Engineering Library

FEB 2 0 1934

February 22, 1934

Engineering News-Record

25 cents. $5 per year. McGraw-Hill Publishing Company, Inc.

A 450-ft. Span Suspension Bridge in San Domingo

❖

Heavy Duty Concrete Road to Norris Dam

❖

Retaining Walls Tests: II—Pressure of Saturated Sand

❖

Reconstruction Following the Long Beach Earthquake

❖

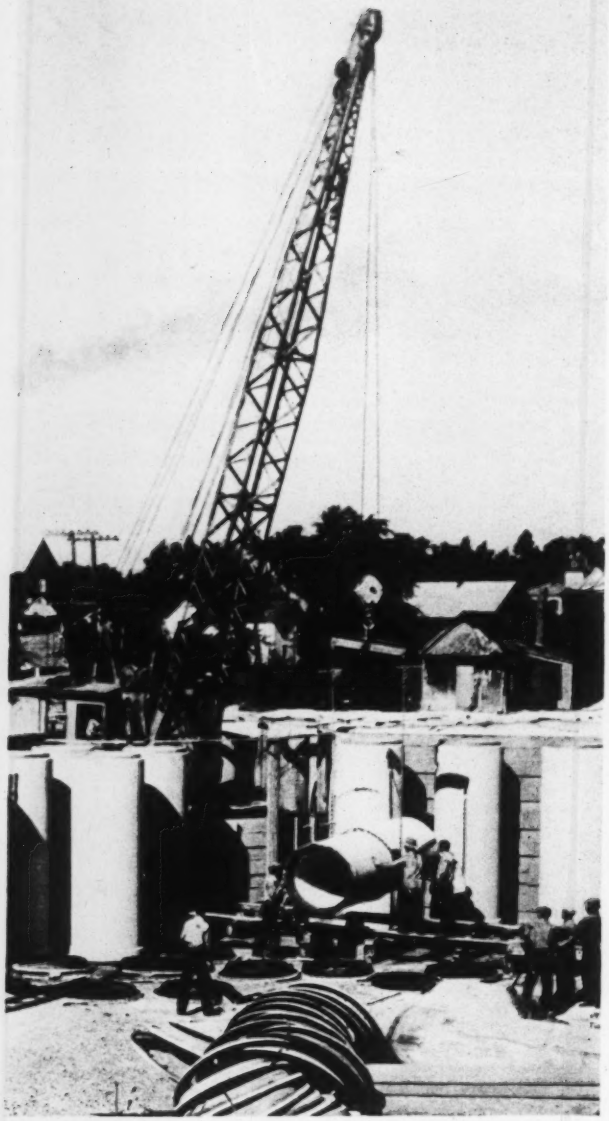
Sodium-Vapor Lighting for Highways

❖

Book Reviews and Notes

Meeting of Illinois Engineering Society

LOCK JOINT PIPE SCORES A HIT ON TO-DAY'S UNEMPLOYMENT PROBLEM



ONE of today's most difficult problems in municipal affairs is to provide adequate Unemployment Relief.

To be of real benefit to a Community, such relief work should not only require the maximum amount of local labor, but should result in creating sound, income-producing municipal improvements.

No better way can be found of obtaining the best solution of the Unemployment Problem than to undertake new pipe line construction, using Lock Joint Reinforced Concrete Pipe.

Manufactured as well as *laid* locally, using local labor and materials, Lock Joint Pipe provides the maximum local relief and, at the same time, assures an enduring, income-producing public asset.

Lock Joint Pipe Co., Ampere, N. J.

Established 1905

Pressure : Subaqueous : Sewer : Culvert

LOCK JOINT
Reinforced Concrete
PRESSURE PIPE

Editorial Staff
New York
V. T. Boughton
W. G. Bowman
C. S. Hill
F. W. Herring
H. W. Richardson

ENGINEERING NEWS-RECORD

F. E. SCHMITT, *Editor*

WILLARD CHEVALIER, *Publishing Director*

Editorial Staff
Chicago
W. W. De Berard
San Francisco
N. A. Bowers
J. I. Ballard

CONTENTS FOR FEBRUARY 22, 1934

VOLUME 112 *Copyright 1934, by McGraw-Hill Publishing Company, Inc.* NUMBER 8

The San Rafael Bridge in San Domingo..... 249
BY CHARLES M. JONES

Heavy-Duty Concrete Road to Norris Dam... 254

Meeting of Illinois Society of Engineers..... 255

Sodium-Vapor Lights for Highways..... 257

Large Retaining-Wall Tests—II..... 259
BY KARL TERZAGHI

Rebuilding Long Beach After the Earthquake 263
BY C. D. WAILES, JR.

Letters to the Editor..... 267

Review of Engineering Literature..... 269

Editorials 270

Current News 272

In the News:

ORGANIZATION of the Construction Code Authority was accomplished Feb. 15 with nineteen of the twenty sponsors of the code represented. Business was chiefly routine involved in adopting bylaws and incorporation, election of officers and committees and establishing Washington headquarters. The Authority also adopted rules for the establishment of a construction appeals board for the Administration's approval and put in motion machinery for nominating employer representatives on the national planning and adjustment board. Thus construction is getting set to undertake self-regulation and make its contribution to national recovery.

PARALLEL to the code authority meeting, the policy committee of the Construction League met to consider making the League more generally representative of industry throughout the country. A temporary system of local organization was developed but permanent planning was deferred to the March meeting.

SIGNING of the General Contractors Code (Chapter 2 of the Construction Code) on February 17 by President Roosevelt was an important event of the week. Definite progress toward developing administrative policy can thus go on unchecked by code uncertainties.

CWA WAGE RATES have been reduced to the prevailing rates in the local communities, with a 30c. per hour minimum. Also, working time is set at 24 hours per week in cities and 15 hours elsewhere.

EASTERN CANADA is experiencing one of the coldest winters ever recorded. The Cascade rapids on the St. Lawrence River about thirty miles above Montreal have frozen up hard for the second time in a month (the third time in 25 years) and this is already causing flooding in residential districts upstream of Montreal. Unless a thaw occurs soon, serious damage may result from the spring flood. Another result of the phenomenal weather is that steel bridges have been subjected within six months to a range of temperature of 160 deg. F.

In This Issue:

THE SHORT-SPAN suspension bridge, always popular in Europe, has in the past few years awakened new interest among American engineers. The trend is important because designers are apt to be more receptive to new ideas in small bridges than in large ones, and thus the development of suspension-bridge design will be fostered. A case in point is presented in this issue in the article describing a 450-ft.-span structure recently built in San Domingo. Sinking the cable saddles into the tower tops and thus reducing eccentric wind loads, and utilizing an asphalt-plank-surfaced interlocking steel-channel floor to reduce dead load and an open-type cable of prestressed strands to facilitate erection and maintenance are significant design elements.

DURING the six months following the Southern California earthquake on March 10, 1933, nearly 8,000 permits were issued by the Long Beach building department, totaling $4,757,000, for repairing damage to buildings. The interesting repair methods together with facts on the extent of the damage and the procedure of providing city approval and inspection are described in this issue by C. D. Wailes, Jr., former chief building inspector of the city.

DAM SITES invariably are far off the beaten path of transportation, requiring special highway or railway construction as an adjunct to dam building. For the TVA's Norris Dam on the Clinch River in Tennessee, a heavy-duty concrete highway has been built over very rough country. Its cost of $257,000 is considerably less than the cost of a railroad. The dependability and large size of modern motor trucks make the road feasible. Its construction is the subject of an article in this issue.

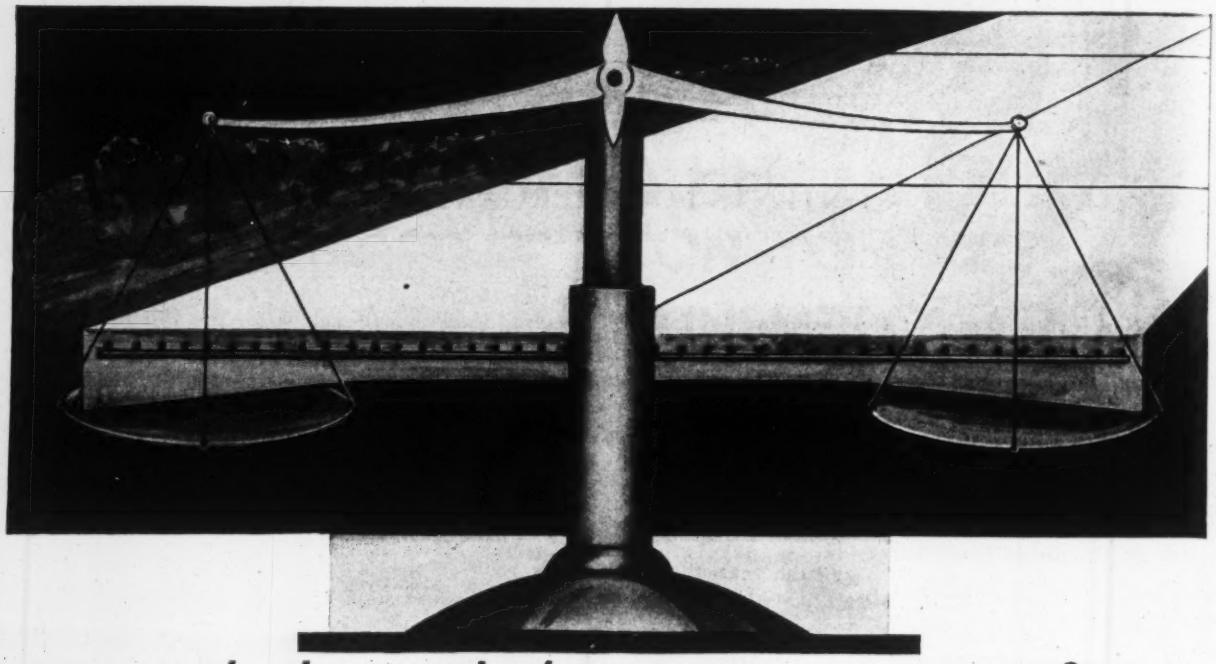
THE ANNUAL MEETING of the Illinois Engineering Society at Springfield produced a stimulating group of papers on many fields of engineering interest. Water-supply and sewage matters were particularly prominent, and a number of the papers contained detailed figures on costs and efficiencies which are given in the report of the meeting in this issue.

SODIUM-VAPOR LAMPS have for some years been proposed for highway lighting on the score that the monochromatic light is not a disadvantage, perhaps is more efficient in emphasizing objects than is incandescent lighting, and unquestionably provides more lumens per watt of power input. Several installations on highways have been made and are described in this issue together with a new type of two-way parabolic reflector.

Coming Articles:

ONE OF THE LARGEST public-works projects that is now being carried on with Recovery Act funds, in addition to being one of the largest river canalizations by locks and movable dams ever undertaken, is the 9-ft. navigation improvement of 650 miles of the upper Mississippi River. Of the 27 locks and dams, four have been completed and fifteen are in the process of construction under contracts let since the PWA appropriation was made. A coming article reviews the engineering surveys and conclusions on which the canalization plan was adopted and selection made of the roller-gate type of movable dam, infrequently used until recently in the United States.

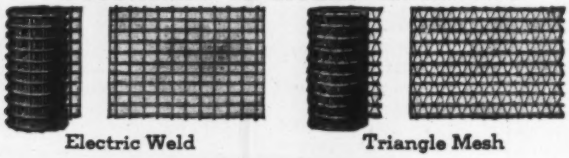
IN ROAD CONSTRUCTION



a balanced design is essential

A BALANCED design reduces future maintenance costs and can only be provided when all parts of the concrete slab or concrete base course develop the same unit stress produced from a constant applied wheel load. Cracks from various causes are liable to form in pavements in spite of predetermined expansion and contraction joints. American Steel & Wire Company Welded Wire Fabric ties these un-predetermined cracks together and maintains a balanced design by assuring genuine load transference across the cracks. Our booklet Reinforced Roads and Streets explains in detail why it is essential to properly balance the pavement design. Your copy will be forwarded upon request.

FURNISHED IN ROLLS OR SHEETS



Electric Weld **Triangle Mesh**

1831 MORE THAN 100 YEARS OF PROGRESS IN WIRE MAKING **1934**

AMERICAN STEEL & WIRE COMPANY

208 South La Salle Street, Chicago
94 Grove Street, Worcester

SUBSIDIARY OF UNITED STATES STEEL CORPORATION
AND ALL PRINCIPAL CITIES

Empire State Bldg., New York
First National Bank Bldg., Baltimore

Pacific Coast Distributors: Columbia Steel Company, Russ Building, San Francisco
Export Distributors: United States Steel Products Company, New York

ENGINEERING NEWS-RECORD

New York

February 22, 1934

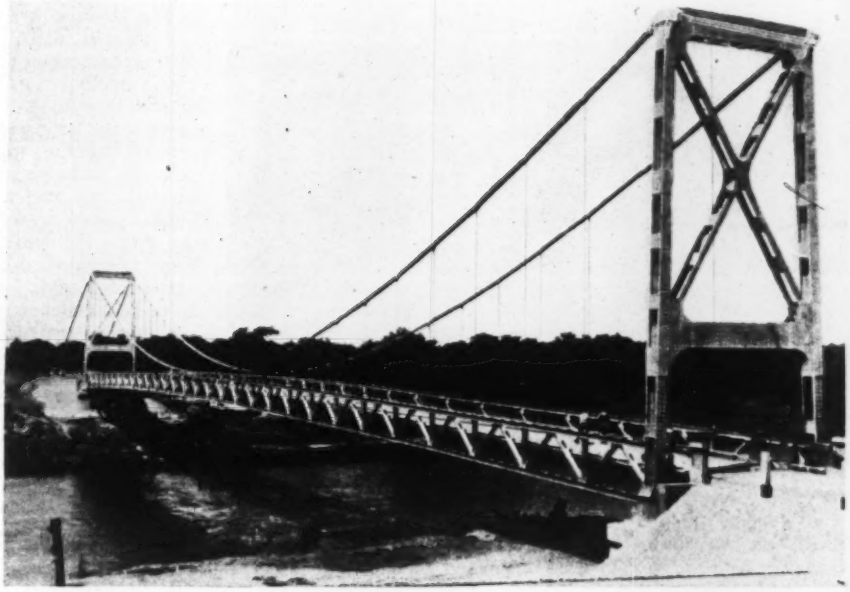


FIG. 1—WEST INDIAN SUSPENSION BRIDGE of 450-ft. span, characterized by open-type prestressed cables, saddles depressed into the tops of the towers and a floor of interlocking steel channels and mineraled-surface asphalt plank.

The San Rafael Bridge in San Domingo

Advanced details of design are represented in a recently completed 450-ft.-span suspension bridge that provides a needed link in the Dominican highway system now being developed

By Charles M. Jones

Assistant Chief Engineer, Bridge Dept., John A. Roebling's Sons Co., Trenton, N. J.

WITH ONE suspension bridge of 450-ft. span in service over the Rio Yaque del Norte and another of 544-ft. span being constructed over the Rio Higuamo, the Dominican Republic is making definite progress in developing a much needed highway system. The structure that is now complete, known as the San Rafael Bridge, is the longest suspension bridge in the West Indies, and in addition is characterized by sufficient innovations and developments of design to make it worth the attention of engineers.

The Dominican Republic and her sister state of Haiti, although vaguely known and little appreciated among North Americans generally, comprise, nevertheless, one of the garden spots of the world. Their history teems with romance, being closely interwoven with such personalities as Columbus, Toussaint l'Ouverture, Dessalines, Leclerc, and Christophe. In Haiti it was the dauntless black emperor, Henri Christophe, who more than a century ago, erected atop a precipitous peak overlooking the Northern Plain an impregnable fortress, Christophe's Citadel, which still stands as one of the great engineering achievements of the Western Hemisphere.

Talent, energy and revenue, which in the early days of the two republics were expended largely on military purposes, have now been given over to the development of the generous natural resources of the countries. The prime requisite of such development is adequate highway transportation. Ordinarily the numerous streams and rivers present no particular obstacles, but after a heavy tropical downpour, they quickly discharge devastating floods, wrecking ordinary bridges and making ferry travel impossible

In an effort to prevent the constant recurrence of such bridge washouts and delays to traffic, and with a further eye to economy, the government engineers are turning to the suspension bridge as a solution of their problem. Seventy-five miles due east of the "Citadelle" is this new San Rafael Bridge. Designed for standard H-15 highway loading, the deck provides for two traffic lanes of 9 ft. each. Simplicity and honesty of design are adhered to strictly, there being not one superfluous line in the entire structure.

Three special features invite attention: (1) for the first time on a suspension bridge, an interlocking steel-channel floor is used, resulting in a saving of approximately 122 tons in suspended

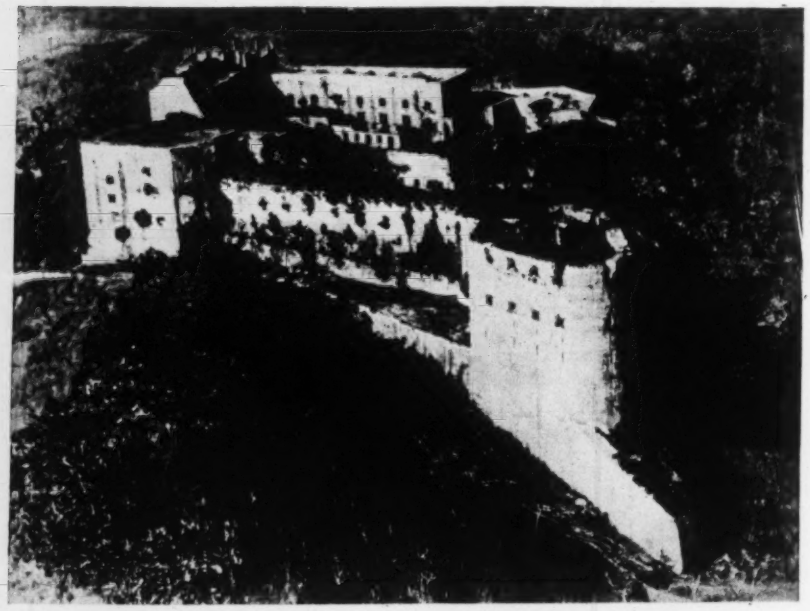


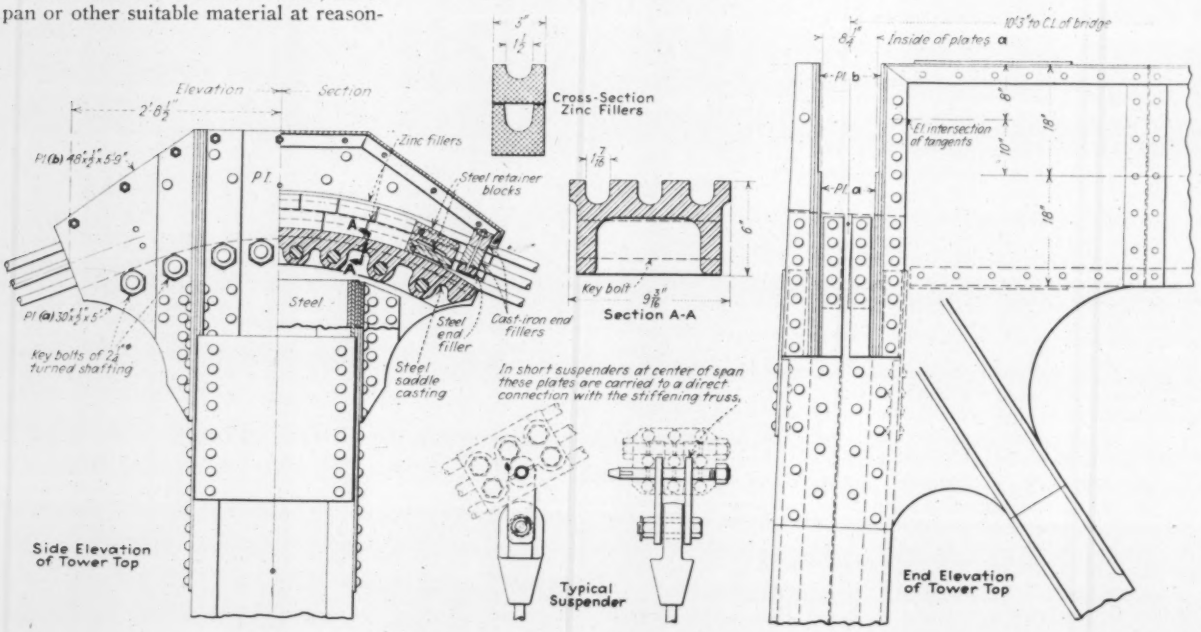
FIG. 2—CHRISTOPHE'S CITADEL, 75 miles from the new San Rafael Bridge, is a famous landmark whose construction a century ago was an engineering achievement. Its original owner is famed in contemporary drama and opera as "The Emperor Jones."

dead load; (2) the main cables represent a further development of the prestressed parallel-strand idea, using open-type construction; (3) The main saddles are built into the structural-steel towers, thereby placing the center line of the cables at the intersection of the main tower members and eliminating the usual eccentric wind loadings at the tower tops. The saddles and cable bands embody new details of design that are worthy of note.

Foundations

Because of the absence of rock, hardpan or other suitable material at reasonable depths, timber piling was used to support the concentrated loadings of the reinforced-concrete piers and anchorages. Each anchorage is a self-sufficient unit, designed with the usual factor of safety to withstand the cable pull; but to provide additional stability, a sand box was introduced in front of the anchorage block. A certain amount of concrete work was required at this point to support the approach fill and to protect the anchor fitting and cable, so that with very little additional material and labor, it was made into a box form and filled with compacted sand.

FIG. 3—CABLE SADDLES are sunk into tower tops so that the center line of the cable coincides with the intersection point of the tower members. Zinc fillers in the saddle casting and special cable-band castings at suspender points maintain the open-type construction of the cable.



Foundations

The facilities available for transporting material to the bridge site dictated that each erection piece should not exceed a maximum length of 21½ ft. and a maximum weight of 3 tons. These requirements governed the number and location of the splices in the tower columns, and also made it necessary to furnish the anchorage bars in two pieces, which were bolted together in the field. Prior to shipment these bars were assembled, drilled and reamed in pairs, fitted with ⅞-in. diameter turned bolts and matchmarked. This procedure assured the proper stress distribution among the bolts and also resulted in two anchor bars of exactly the same length for each of the four main cable terminals. After shop assembly, the stiffening trusses were completely dismantled and each member was shipped as an individual unit.

Towers and saddles

The towers are of the fixed flexible-column type, 57 ft. 11 in. high. Each leg has a batter of 21 in. and is anchored to the concrete pier with six hold-down bolts, 2¼ in. by 19½ ft. The main column section is made up of a 24-in. 70-lb. I-beam with the web parallel to the center line of bridge and two 18-in. channels riveted on as flanges. Batten plates on the inner and outer face of each column provide increased stiffness. The longi-

tudinal stiffness factor of one column is 734; that is, a horizontal force of 734 lb. applied at the top of a column will deflect it 1 in. under no vertical load. Determination of the stiffness factor under varying vertical loads is essential in arriving at the unstressed lengths and proper adjustments of the cable strands.

The most unusual and novel treatment of the tower design is the location of the saddles. Up to this time, so far as is known, all main saddles have been placed on top of the columns and either remain protruding, as found on the Ambassador, Bear Mountain and other bridges, or else they are later covered over by some ornamental treatment as on the George Washington and St. Johns bridges. This conventional location results in eccentric wind loadings at the tower tops, and it is customary to provide heavy steel castings to transmit these loads from the main cable to the tower proper. On the San Rafael Bridge the saddle is located in such a position as to bring the center line of the cable at the intersection point of column, top strut and diagonal, bringing all resultant forces to a common point and permitting a clean-cut tower top devoid of artificialities.

Inasmuch as each of the two main cables is made up of nine parallel 1⅜-in. galvanized prestressed bridge strands, the lower section of the saddle was made of a steel casting with three parallel grooves, to take the lower three strands. These grooves are spaced on 3-in. centers and finished to 55¼-in. radius, or approximately 40 strand diameters. The vertical load of the main cable is transmitted to the column through eight 2¼-in.-diameter, turned and ground key bolts as shown in Fig. 3. After the lower layer of strands had been erected and adjusted in the field, saddle fillers made of reinforced zinc, cast to the correct radius, were set on top of the steel saddle section to receive the second strand layer, which, when adjusted was covered with another set of zinc fillers to accommodate the top strand layer. The entire saddle assembly was covered with a steel, weatherproof hood. With this arrangement, strand bearing pressures are negligible, for no strand bears on the saddle with pressures other than its own, whereas in a closed cable the lower strands are subjected to a compressive load from all the upper strands.

Prestressed parallel-strand cables

The use of multiple twisted strands laid parallel to form a main cable, as on the San Rafael Bridge, is not a recent development in suspension-bridge design. On the Massena Center Bridge, erected in 1910 (*ENR*, Oct. 5, 1912), Holton D. Robinson, the designer, used seven 1½-in. strands in each of the two main cables. From this time until the erection of the Grand' Mère Bridge in Quebec in 1928-29 (ENR, Nov. 28, 1929), no bridges of note were built in North America with parallel-strand cables, although a number of strands going into cables of this type were furnished for export. This type of cable received little consideration during this time because:

1. The strands had the relatively low modulus of elasticity of 20,000,000 lb. per sq. in., which either necesitated additional metallic area to provide an ample AE, thereby reducing elongation under live load, or required increased effectiveness of the stiffening truss to counteract the elongating tendency.

2. Cumbersome and expensive terminals were required at the anchorages to provide an individual connection and adjustment medium for each strand.

3. The strands themselves were "cranky," tending to "bird-cage" or open up when handled in the field.

These objections have now been overcome. Through the innovation of prestressing, developed by the writer's company in connection with the footbridge cables for the George Washington Bridge (ENR, May 1, 1930), the modulus of elasticity of bridge strands has been increased to 24,000,000 lb. Also, as the prestressing tension is usually one-half the ultimate strength of the strand, each strand is subjected to a proof test greater than the working stress to which the material will be subjected in service. (The ultimate strength of the San Rafael strands was 223,000 lb. and the working stress 70,000 lb. per sq.in.) While in the prestressing plant, each strand is measured to exact length under its dead-load tension, thereby reducing the necessity of field adjustment to a minimum. Strands as long as 2,722 ft. have been furnished (St. Johns Bridge), and actually accurate in length within ±1 in. Furthermore, while under working tension, the exact locations of center lines of saddles and cable bands are determined and marked on the strands. For example while under tension at the prestressing plant, zinc buttons were cast on each San Rafael strand on each side of the saddle position. After erection, and during adjustment, the buttons were shimmed against bearing blocks extending from the saddle, which not only provided minute individual strand adjustment but also assured that subsequent strand movement would not disturb a strand previously adjusted.

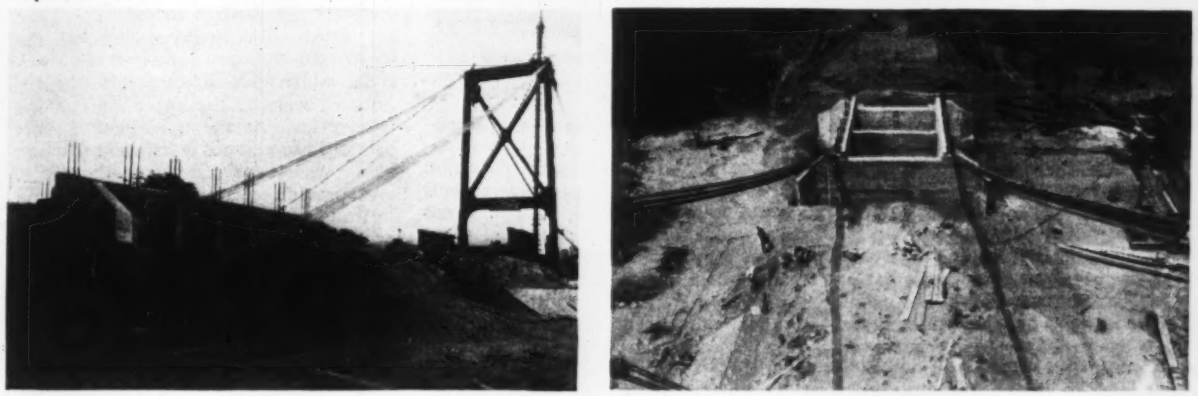


FIG. 4—CABLE ANCHORAGES rest on piles, and added stability is secured by a sand-filled concrete box (right) placed in front of the buried anchorage block. The box also supports the roadway.

A compact-type anchorage, patented by the writer's company and used on the San Rafael Bridge, has greatly simplified and reduced the cost of the cable terminals. This fitting provides for such limited field adjustment as may become necessary by the addition or omission of shims between the fixed bearing blocks and the bearing face of the socket. Bridge-strand sockets are designed with bails, which may be engaged with a jack or a pulling rope for the adjusting operation. The bearing blocks are bell-mouthed where the strand emerges and are designed to provide the proper support for the strand as it bends from the anchorage to the splay point.

Finally the "crankiness" of bridge strand has been overcome through improved manufacturing processes, with the result that a number of bridges using prestressed strand cables have been built. Perhaps the best example of what can be accomplished through prestres-

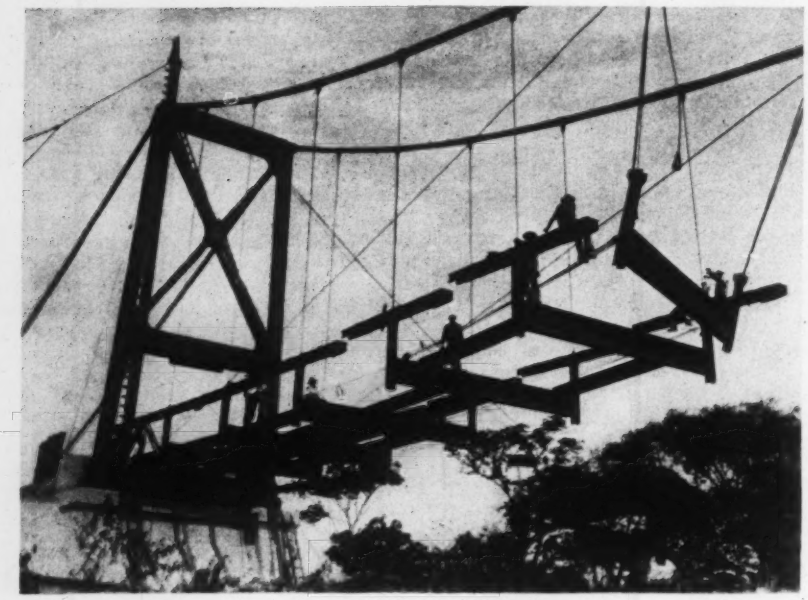


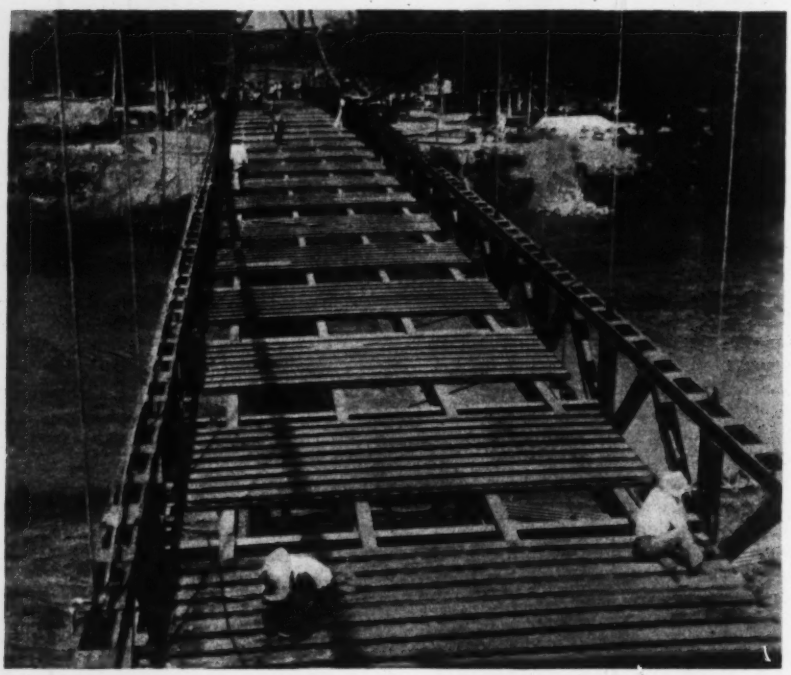
FIG. 5—ERECTION of the San Rafael Bridge was carried out with simple, lightweight equipment and native labor.

sing is the Skyride suspension system at A Century of Progress, where 328 individual pieces of prestressed bridge strand were furnished in 38 different lengths with practically no provision and no need for field adjustment.

The cables on the San Rafael Bridge are of open-type construction—that is, the individual strands are not bound closely together but are placed and held far enough apart to permit ready inspection at all times and to allow painting whenever it becomes necessary. Adopted primarily to save wrapping costs and to facilitate inspection and maintenance, the open type reveals several other advantages. The apparent diameter of the cable is increased about 80 per cent, accentuating the graceful cable curve and lending an added appearance of ruggedness to the structure. Strand adjustment is comparatively easy because no one strand bears against another. Cable band pressures are multiplied by the number of strands in a horizontal layer, in this case threefold. Therefore, lower bolt tension is permissible, or conversely, with the same total bolt tension as would be applied on a closed cable, three times the gripping action is secured.

With the open-type construction it is practical to erect cables with a total metallic area of about 35 sq.in., or of an ultimate strength of approximately 7,700,000 lb. each, nearly four times that of the San Rafael cables.

FIG. 6—A WELDED FLOOR of interlocking steel-channel type, surfaced with asphalt plank, gave a substantial weight reduction and permitted elimination of diagonal floor members by virtue of its lateral stiffness.



Cable bands and suspenders

To accommodate the open construction cable, a highly efficient articulated band was developed which assured gripping on each of the nine strands and whose cross-section is only slightly larger than that of the main cable. The result is pleasing esthetically, in that the cable curve is not interrupted at each panel point by a noticeable lump.

Prestressed bridge strands 1½ in. in diameter are used as suspenders. They are fitted with closed sockets at the upper ends and open sockets at the lower ends, which pin directly into the reinforced webs at the upper ends of the truss posts. At the upper end a short pair of links extends a sufficient distance below each band to engage the socket and provide clearance. No provision is made for adjustment, because of the accurate predetermined lengths of the suspenders.

Novel floor

There is nothing unusual in the design of the stiffening truss, which has a slenderness ratio of 1/75 and thirty panels uniformly spaced at 14 ft. 11¼ in. It is a conventional modified Warren type, rectangular batten plates being used, rather than lacing, to tie the channels forming the top and bottom chords, thus carrying out the simplicity of lines which is preëminently characteristic of the entire structure. The floor beams are 24-in., 70-lb. W.F. sections riveted to the lower part of the vertical posts, and the stringers, spaced 5 ft. on centers, are 15-in., 35-lb. sections.

For what is believed to be the first time on a highway suspension bridge, a lightweight durable flooring is used. Consisting of interlocking steel channels, placed alternately up and down and covered with a mineraled-surface asphalt plank, it has a total weight (steel and asphalt) of 45 lb. per sq.ft. of roadway area. The channels are laid at right angles to the stringers, to which they are plug-welded. The channels were furnished in units of eight, welded together in the shop and curved to the proper roadway crown.

After being welded in place on the bridge, the channel troughs were closed with asphalt fillers placed in asphalt cement. This produced a smooth surface to which a longitudinal flooring of mineral-surfaced asphalt plank was

cemented. The resulting roadway is smooth, anti-skid and resilient, and promises to stand up well under the trying conditions of tropical service.

Aside from the economy of weight reduction of floor, which also reduces the material required in cables, towers and anchorages, this type of floor permits the omission of the usual diagonal members of a wind system. In effect, the lateral wind system becomes a deep plate girder of which the channels act as a web and the truss chords as the flanges. The omission of diagonals from the windbracing is a further addition to the clean-cut appearance of the

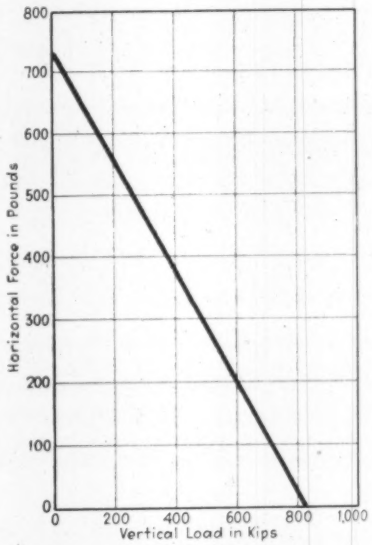


FIG. 7—TOWER DESIGN was based on a stiffness factor of 734. This chart shows the horizontal forces required to establish equilibrium at 1-in. deflection per tower leg under various vertical loads.

job. The Belmont Iron Works, Philadelphia, and the Johns-Manville Co. cooperated in providing the floor and the former company fabricated all structural steel as well.

One provision of the contract with the Dominican government stipulated that native labor be employed, the only exception being the services of one resident engineer from the Roebling staff, under whose supervision the entire superstructure was erected. His bridgemen were recruited largely from the native peasantry and had to be taught the intricacies of matchmarking, rigging, riveting and the like. In the early stages of erection the going was slow, especially so with the riveting gangs, and as a result many rivets had to be cut out and redriven before acceptance. However, the men were receptive and eager, and with the passing of a few weeks, able foremen were developed, and the gangs picked up in efficiency to such an extent that the bridge was completed in ten weeks.

Erection equipment was of the simplest sort and consisted mainly of: a three-drum, 30-hp., steam hoisting engine, a three-drum, 15-hp. gasoline winch, a 40-ft. gin pole of 10-in. diameter hard wood, a 63-ft. gin pole of 13-in. square yellow pine, a two-cylinder gasoline compressor and a portable gas-electric welding machine, together with other miscellaneous small tools and equipment.

Procedure—The 63-ft. gin pole was first set up on an anchorage pier, from which position the two lower column sections and the roadway portal struts were placed. The pole was then jumped to the top of the roadway portal, from where it completed erection of the tower steel.

Strand reels were mounted near the anchorage, and the outer strand socket was attached to a pennant on an endless rope, which extended around a return sheave on the far side of the river. In this manner one strand at a time was hauled out and extended from anchorage to anchorage. After the two end sockets were connected to the anchor fittings, whip lines were lowered from the top of each tower, and the two bights of strand hoisted and set into the saddle grooves. Strand adjustment was controlled from a wye-level mounted on one tower leg.

Cabled bands were hoisted to the tower top, clamped loosely around the strands and hauled out to their premarked positions by means of manila tag lines. The men found no difficulty in working their way out to positions in the main span, the open cable providing a good broad seat and the individual strands allowing a firm hand grip. Suspenders were hoisted into position from the river, the cable men making the attachment to the bands.

Truss and floor-steel erection commenced at each tower and progressed simultaneously toward midspan. Light falls, attached to the main cables and moved by hand from panel point to panel point, were sufficient for swinging the suspended steel into position. No top-chord connections were made until all truss steel, floor beams, stringers and one-half the floor channels were in place, at which time the top chord was loosely bolted up but not riveted. As it is highly desirable that the stiffening truss be closed in a "no-stress" condition, the top chord was riveted only after the entire suspended dead load was in place.

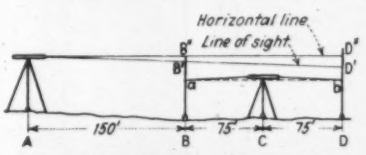
The bridge was designed, furnished and erected by the John A. Roebling's Sons Co., under direct contract to the San Dominican government, for which A. W. Rogers is chief engineer. W. A. Reeve was resident engineer for the Roebling company, and Andrés Pastoriza acted as subcontractor for erection. His Excellency, President Rafael L. Trujillo, under whose public-works program the bridge was constructed, officiated at the dedicating ceremonies on Sept. 15, 1933.

Simplified Peg Method for Adjusting Engineer's Level

By Richard Bennett
Phoenix, Arizona

THE FOLLOWING is a simplified adaptation of the peg method for making the bubble adjustment on engineer's levels. The greater accuracy obtained and time saved will be apparent to those engineers who are responsible for the adjustment of instruments on construction work. When the required stakes are set in a protected spot, to save time in re-establishing them, it requires only a few minutes to periodically check a level.

Four stakes are set in a measured straight line, 150, 75 and 75 ft. apart respectively, and for reference purposes are called A, B, C and D, as shown on the accompanying diagram. The instrument is set first at point C, midway between the points B and D, which are approximately on the same level. The site should be selected with this idea in mind. A plug is firmly driven at B to any convenient height, and its elevation below the instrument is noted. The instrument is revolved 180 deg., releveled, and plug D is set with the top at the same elevation as B, with readings *a* and *b* equal.



SIMPLIFIED METHOD of making adjustment of level bubble.

The level is next set at point A. If the line of sight and bubble are parallel, so that the line of sight is horizontal when the bubble is in the center of its tube, the rod readings B″ and D″ are equal. But in the example shown above the line of sight points down, the rod readings being B′ and D′, respectively. To determine the rod readings for B″ and D″, find the difference in rod reading of B′ and D′ by subtracting the last from the first, and this sum added to B′ gives the correct elevation for B″, D″ and also for the instrument.

$B' + (B' - D') = B'' = D'' =$ height of level.

The line of sight should now be brought to read B″ D″ by the leveling screws. The bubble will move out of the center of its tube and should be brought back to the center by the bubble adjusting nuts. When this last adjustment is completed, the bubble tube will be parallel to the line of sight because both are horizontal.

Heavy-Duty Concrete Road to Norris Dam

All hauling from railway to great dam of the Tennessee Valley Authority will be over concrete highway 4.8 miles long, contracted to be finished in 69 working days

TRANSPORTATION of materials, machinery, equipment and supplies needed in building the $34,000,000 Norris Dam project on the Clinch River in Tennessee by the Tennessee Valley Authority will be entirely over a 4.8-mile, heavy-duty, concrete-paved highway from the rail head to one end of the site of the dam. No rail connection will be built. Even the large generators and water wheels for the power house will be brought in over the heavy-duty highway.

There was a controlling factor in the construction of this road. Like all other work projected under the federal administration activities to relieve unemployment, one purpose of the Norris Dam was to give men work quickly. To do this, the service highway had to be built quickly, and speed was made a prerequisite of the contract. The general procedure was to throw a large volume of equipment onto the work and place the units in operation at a number of points at the same time. This involved a rather strenuous task of moving heavy equipment over rough country and roads scarcely better than trails. Bridges had to be shored up, and often improvements had to be made in the roadway.

Road preferable to railway

Estimates of the cost of building Norris Dam, prepared several years ago before the creation of the Tennessee Valley Authority, included a rail connection to the site at a cost of $750,000. In addition, a macadam-surface highway was included at a cost of $150,000.

Progress made since then in the size and dependability of automotive equipment and in the design and construction of highways was a large factor in the decision to eliminate the rail connection. The original estimates also contemplated importing all the concrete materials. Extensive tests made by the TVA proved that crushed stone and sand produced from the limestone at the site would make better concrete than the materials previously considered. The tonnage required to be moved to the dam was thus so greatly reduced that it was easy to handle it economically over a highway.

An expenditure of $257,000 is contemplated for the heavy-duty highway, which is somewhat more than it might have cost if there had been normal time in which to do the job. But early completion was a prime factor, since the existing roads were entirely inadequate to handle more than the traffic already on them.

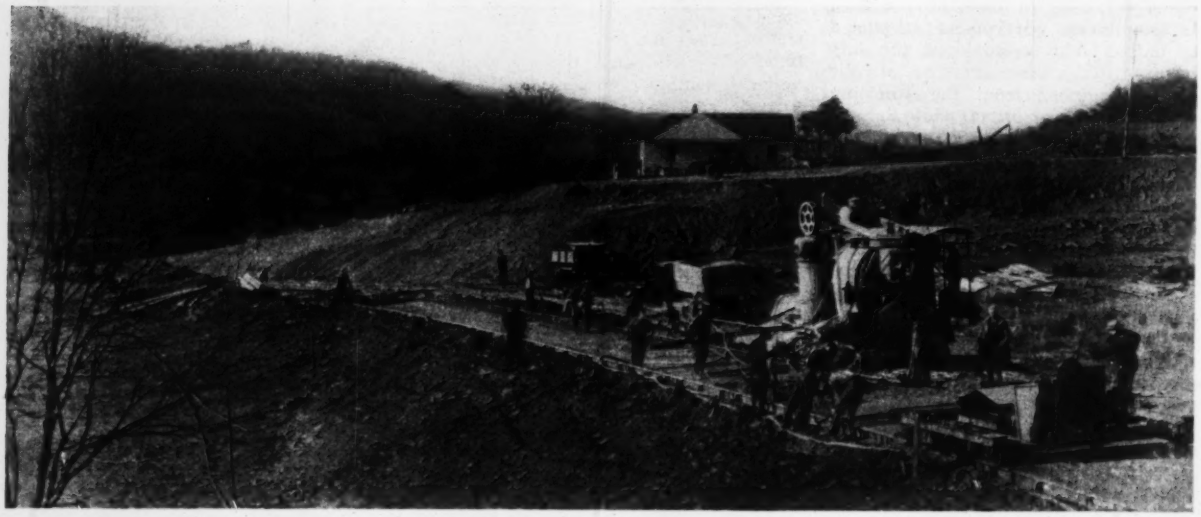
Starting from the main-line connection with two railroads at Coal Creek station, the highway passes through a broken foothill country. At the dam it ends at the crest of the spillway at one end of the site. Following the completion of the dam, this highway will be a link in a loop superhighway that is under construction from Knoxville to the dam and return. A great volume of sightseeing traffic from all parts of the country already is visiting the project, and this volume is expected to increase rapidly, making the early completion of the loop desirable.

To provide the type of transportation facilities needed during the construction of the dam, it was decided to adopt for the heavy-duty highway a ruling grade of 6 per cent and curves having a minimum radius of 300 ft. The reinforced-concrete slab paving has a normal width of 22 ft., with the usual increase in width on curves. Shoulders 3 ft. wide were adopted, with drainage ditches of varying widths, depending on local conditions. The paving is a 10-8-10-in. slab reinforced for a rolling load of 20 tons, spaced on six wheels.

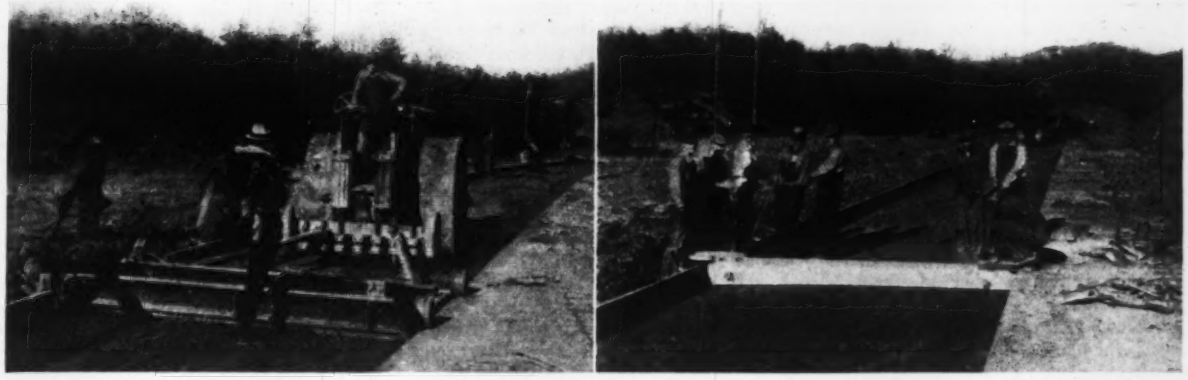
This combination of standards called for 190,000 yd. of excavation, much of which is solid rock. A contract for the entire job was let to W. W. Boxley & Co., of Roanoke, Va., on the basis of completion in 69 working days. This limited time was necessary not only on account of the inadequacy of the existing roads but also because work on the dam went forward faster than schedule.

Construction procedure

Grading was started almost simultaneously with six large power shovels spotted along the line. Since the location is largely sidehill, much of the excavation could be sidecast. Motor trucks handled the shovel spoil to the fills. Bulldozers on crawler-tread tractors spread the fills in thin layers and kept the material compacted. No sprinkling or jetting to induce settle-



CHARACTER of country traversed by service road to Norris Dam. Mixer is working to one side of first strip of paving to avoid rutting the fine grading.



SUBGRADING by power is shown at left. This grade was finished by hand, as shown at right.

ment seemed necessary with the class of material handled.

By working seven days a week almost without break up to the end of December, the contractor had finished 170,000 yd. of the grading.

Concrete placing was started at the rail end of the job as soon as enough grade was in shape. It was decided to build half the width of the slab through to the dam to provide quick access to the latter. Then the second strip was to be completed as rapidly as practicable.

Cement, sand and broken stone for the concrete were delivered by rail to a batcher plant at Coal Creek station. An extra-large crawler-mounted crane was installed to handle the materials with a view to stockpiling in order to avoid shutdown in case rail deliveries were irregular.

All the power equipment that could be used to advantage was employed in rolling, fine grading, preparing the subgrade and other operations. Finishing also was done by means of machine.

Motor trucks delivered from the batcher plant to the paving mixer. Much of the time the mixer was operated at one side of the grade on the first strip to permit it to work close to the fine grading. Occasionally, when the mixer caught up with the grading, it was shifted back to complete the second strip for a short distance. On such shifts the mixer operated in line with the second strip, not running on the recently placed first strip.

Favorable weather conditions eliminated any difficulty in curing the concrete. When light freezes occurred or were expected, hand oil-lanterns placed under light wooden frames set over the concrete and covered with canvas kept the concrete surface warm enough.

Some settlement of the newly made fills is expected, but urgent need of the completed highway would not permit waiting for the shrinkage to occur. To avoid risk of damage to the concrete slab, having in mind the heavy loads it must carry, mud will be pumped under the slab wherever necessary. An instrument man will be assigned to keep close check on the fills for a few months. To date, no settlement has been noted. If any is detected, mud pumping will be started and kept up long enough to support the slab. The expense of such maintenance is expected to be nominal.

Construction activities of the Tennessee Valley Authority are under the general supervision of Arthur E. Morgan, chairman of the board. C. H. Locher is construction consultant, B. M. Jones is engineer of construction, and Ross White is construction superintendent on the Norris Dam project. J. W. Bradner, Jr., has been engineer in charge on the heavy-duty highway for the TVA, while W. B. Bray has directed the operations of the contractor.

Subjects of Wide Interest Discussed at Illinois State Society Meeting

Data on sewage, water, drainage, roads and structures, with particular emphasis on sludge digestion and utilization, contained in papers presented at Springfield meeting

Engineering News-Record Staff Report

WITH seven technical sections holding sessions, the Illinois Society of Engineers at its meeting, Jan. 31, Feb. 1 and 2 at Springfield, covered the civil engineering field rather completely, but sewage, water, drainage, roads and structures received the bulk of the attention.

Sewage treatment

Sewage treatment, particularly sludge handling, because of the present agitation for chemical treatment and mechanical filtration as against digestion and sand-bed drying, was gone into most thoroughly of any of the subjects.

Sewage-Gas Use—A year ago the Springfield Sanitary District installed a gas engine to operate on sludge gas. Progressively this engine has taken on most of the power load required to operate the activated-sludge plant. While this is not the first nor most important adaptation of a gas engine to sewage-treatment plant practice, it is probably the largest installation that has been operated continuously and successfully in America. Birmingham, England, and Berlin, Germany both have larger plants. Last year W. B. Walraven, engineer of the District read a paper before the society which described the installation. This year he presented performance statistics and results of experiments.

Four fundamental requirements of the fuel are as follows:

1. 1 b.hp.-hr. should be developed for each 10,000 B.t.u. on normal engine ratings. 2. The rate of combustion of the gas and the power available therefrom must be such that the normal engine rating can be maintained. 3. The gas must not seriously corrode the valves nor the cylinder walls. 4. The gas-air mixture must not deteriorate at economical working pressures.

On test the engine used 10,085 B.t.u. for 1 b.hp.-hr. at full load. At half load it required 13,500 B.t.u. for the same work, which is not far out of line with commercial installations.

Except for the priming cups and spark plugs the engine parts show no evidence of corrosion after a year's operation. The valves are of silicon-chromium-steel alloy. They have been ground four times but show no excessive pitting. Sulphur, which can be

removed by scrubbers, causes most of the corrosion. While scrubbers are not a part of the Springfield equipment, Mr. Walraven feels that they should be used when an engine company feels that corrosion is a hazard, as they are not expensive to install or maintain.

A compression ratio of 5.5 to 1 is used safely. The timing, originally set to fire at 10 deg. ahead of dead center, was moved up to 23 deg. advance, with resulting higher efficiency.

Besides recovering 25.2 per cent of the heat energy in the gas as useful work, waste heat maintains the temperature of the sludge in the coils of the digestion tanks. The water is circulated through the digestion-tank coils, maintaining a temperature of 95 deg. F. and returned to the engine. It absorbs from the engine and transfers to the sludge 133,000 B.t.u. per day for each b.hp. delivered. In summer the exhaust-gas heat is wasted because the water-jacket heat is sufficient to keep the tanks warm. It is contemplated to use this heat to aid in drying the sludge and screenings preparatory to incineration. As to costs (see *ENR*, Jan. 4, 1934, p. 8), experience to date indicates that the plant will have paid for itself in three years over and above buying electric current at 1c. per kw.-hour.

Sludge Costs — The cost of sludge digestion, dewatering and disposal as actually found in existing plants by present methods has received added attention of late because of the increasing interest in mechanical filtration and incineration or other disposal. Practicability depends on relative costs. Harry F. Ferguson, chief sanitary engineer, and W. Homer Wisely, assistant sanitary engineer, both of the Illinois department of public health, gave results of a study of six well operated Illinois plants all using digestion and sand drying. The plants are at Aurora, DeKalb, Galesburg, Peoria, Rockford and Springfield. The cost of the removal of dried sludge from the drying beds averaged 40c. per cubic yard. Resanding requirements varied from $1 to $6 per 1,000 sq. ft. and reflect the loading of the beds. Dried sludge is sold (at relatively small figures) at all plants except Springfield and Peoria.

Sludge drying comprises about 20 per cent of the total cost as an average of the six plants, ranging from 14 to 35 per cent. The costs of digestion, drying and disposal per capita yearly vary from 7.4c. at Springfield to 36c. at DeKalb. Per million gallons treated, the variation in cost is from $2.12 at Springfield to $16.50 at Peoria; and per ton of dry solids to the digestors, from $3.57 at Springfield to $20.82 at Galesburg.

Comments on the above paper and one by S. A. Greeley and C. R. Velzy in which results were worked out theoretically for various-size towns indicate the following: Mechanical filtration is not economical for plants serving less than 50,000 persons. Estimated costs for mechanical filtration on digested sludges are higher than the actual costs for the six Illinois plants. Cost estimates of mechanical filtration of raw sludge compare quite favorably for plants serving 100,000 persons or more with the costs of combined digestion and sand drying found at the six Illinois plants.

Beer Slop — Sludge digestion at Peoria is complicated by industrial wastes, particularly "beer slop" which is brought to the plant by a separate pipe. L. S. Kraus, chemist, Greater Peoria Sanitary District, in his paper on the subject, stated that this waste is very concentrated and lends itself to direct decomposition by anaerobic digestion more readily than to purification by the activated-sludge process. Beer slop is first digested and the digested liquor mixed with the raw sewage. The combination is then treated by the activated-sludge process. The chief difficulty in the digestion of the mixture of activated sludge and fresh solids is the maintenance of a suitable supernatant liquor. With a 3 per cent concentration and a digestion period of 25 days, it is difficult to prevent the tank contents from becoming homogeneous. Two-stage digestion has been used, liberating most of the gas in a short initial period and giving time in a second period to separate the sludge from the supernatant liquor. Volatile acids causing foaming must be kept down.

In carrying out the two-stage digestion the load in the first tank was increased cautiously until the tank was taking all of the sludge in the plant. Primary-tank sludge was introduced into the top of the first-stage tank, and sludge was pumped simultaneously from the bottom of this tank into the top of the second-stage tank. Sludge was wasted from the bottom of the second-stage tank either to the drying beds or to the sludge-storage tanks. Supernatant liquor was withdrawn from the second stage to the primary settling tanks.

Beer slop comes to the plant at 160 to 200 deg. F., and water is circulated first through the beer-slop digestion tanks and then through the coils of the normal digestion tanks, carrying the heat from the first to the second.

Overload Effect — By putting two overloaded sewage-treatment plants of Villa Park, Ill., under laboratory control a creditable result has been obtained. R. T. Reilly, of Alvord Burdick & Howson, consulting engineers, Chicago, described the situation, which must be endured until funds are available to augment the capacities. The plants are of the Imhoff tank and sprinkling-filter type without secondary clarification.

The experience in operating the plants through the critical months of June, July and August demonstrated their ability to handle an overload of approximately 25 per cent based upon population, while reducing the five-day biochemical oxygen demand of the raw sewage from about 180 p.p.m. to from 20 to 40 p.p.m. in the effluent. All functions of the plants performed excellently throughout this period except for the heavy unloading action of the beds. This resulted in higher suspended solids and somewhat higher oxygen demand values in the effluent.

In view of the ability of the plant to take this overload it was decided to experiment with the addition of "Ovaltine" wastes which were severely polluting the stream. They represented an additional oxygen demand of 1½ times that of the domestic population of Villa Park. First by adding half of the 10,000 gal. per day of the waste, having 7,000 to 9,000 p.p.m. of B.O.D., the B.O.D. of the sewage increased from 175 to 290 p.p.m. A treatment efficiency of 87 per cent was obtained. Then the whole of the wastes were added and the same efficiency obtained, but the raw sewage then contained 404 p.p.m. of B.O.D. Nitrification was materially reduced, but temperature is considered a large factor.

Water supply

Well Survey—Through use of CWA men the Illinois State Water Survey is making a canvass of all the wells of the state and expects to have records of 100,000 wells as to yields, draw-down and influence on neighboring wells. W. D. Gerber, engineer of the survey, called attention to many cases of overpumping which, particularly in the Chicago area had ruined the wells. Some draw air. Now 2,000 wells can be used only for condenser water. The earliest wells flowed 75 ft. above the ground surface; now, in most of them, the water is 350 ft. down. Mr. Gerber saw as yet no tendency toward a state control by which a permit of necessity and convenience would have to be obtained to tap the fast-dropping underground source.

Elbow as Meter—The possibility of using an elbow in a pipe as a device for measuring water has been investigated at the University of Illinois hydraulic laboratory. W. M. Lansford described experiments which indicated a constant relation between the difference in pressure at the outside and inside bends of an elbow and the velocity head of the water in a pipe. It was concluded that an elbow makes a good meter where normal velocities are greater than 1 or 1½ ft. per sec., which means that reducers and elbows smaller than the run of the pipe would be desirable.

Pipe Tightness—Involved in the new water supply of Flora, Ill., is a 12-in. lead-jointed pipe line 20,700 ft. long from a river intake to a filter plant and 6,200 ft. thence to the city. Leakage was limited in the specifications to a maximum of 3 gal. per hour per 1,000

ft. as determined by the quantity of water to be pumped into the lines to maintain 150 lb. in the long line and 200 lb. in the high-service line. The tests were reported by A. C. Stanfield, consulting engineer. The leakage in the whole length of low-pressure line showed 1.16 gal., and in 4,000 ft. under 200-lb. pressure it showed 1.07 gal. Shorter sections of the same pipes ranged up to 2.36 gal.; and one section (6,380 ft. of low-pressure line) showed but 0.86 gal. In making the test a gasoline-driven triplex pump with single-acting cylinders and a capacity of 60 gal. per min. was used. Five air-relief valves were used on the lines at summits. All pipes were tested and approved before covering. The cost of labor, at 30 to 75c. per hour, for 28,097 ft. of 12-in. pipe (except 1,062 ft. of 10-in.) was 16c. a foot for hauling, excavation, laying, testing and backfilling.

Lake Springfield—A full history and description of the Lake Springfield project was given by C. S. Timanus, of Burns & McDonnell Engineering Co. He stated that the depression had helped in the purchase of the large amount of land involved—4,260 acres of flooded land and about the same amount of marginal land, much of which will be available for lease to private owners for the building of summer homes. The lake is the largest in the state, with 60 miles of shore line. The land cost an average of $107 per acre, and clearing in the flooded area cost $38 per acre. The lake stores 2.6 billion gallons. Some of the statistics are as follows: two dams, six bridges, 7 miles of railroad relocation, 25 miles of new marginal roads, 12 miles of sewers, much reforestation, riprapping, a new $1,000,000 electric power and pumping plant, a 12-m.g.d. filter to cost $300,000, a 1,600-ft. dike, and five automatic drum spillway gates. The total investment will equal that of the present water system.

Structural materials

Fatigue—H. F. Moore, research professor of materials, University of Illinois, in concluding his paper on "The Importance of Fatigue of Metals to the Structural Engineer" said that fatigue of metals was only of occasional concern to this branch of engineering. Where repeated stress and corrosive action occur simultaneously, fatigue may assume importance.

Mortar-Void Theory in Practice—V. L. Glover, engineer of materials, Illinois division of highways, outlined the method of putting into practice the principles involved in the mortar-void theory of concrete proportioning developed ten years ago. The method was first used in 1930, and the relation between mortar and coarse aggregate was established virtually by trial. During 1931 the proportioning engineer was supplied with a "fine aggregate" chart for the particular sand used and a "coarse aggregate" chart showing the approximate relation between the percentage of voids in the coarse aggregate and the amount of coarse aggregate which could be used with a cubic foot of mortar in pavement construction. The latter chart was revised in 1932 to obtain greater accuracy. In 1933 the same charts were used. Results are as follows in averages of flexural strength after fourteen days: 1929, before the mortar-void method was introduced, 642 lb. In 1930, '31, and '32, corresponding figures are 693, 786 and 864. More striking results are noted in cores drilled from the pavements. In 1927, '28 and '29 the average compressive strengths were 3,948, 4,268 and 4,157 lb. per sq.in. respectively at an average of 240 days. For 1930, '31 and '32 the figures are 4,473, 4,635 and 5,281 lb. respectively at 125 days.

Sodium-Vapor Lights for Highway Illumination

Installations on several hazardous stretches of road in New York and New England indicate superior effectiveness of new type of lamp and reflector

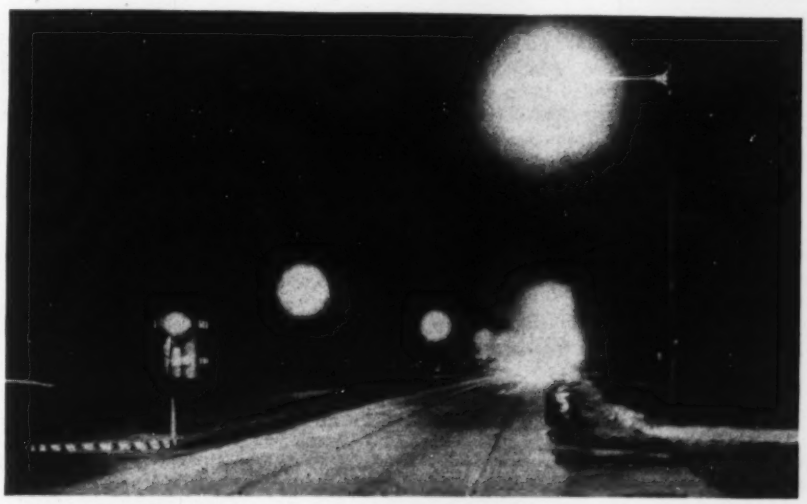
A NEW TYPE of sodium-vapor lighting unit has been installed this year along four highways in New England and New York. The installations are at Revere Beach and Newton, Mass., Wallingford, Conn., and Schenectady, N. Y. With a light output of 10,000 lumens, the new units require only as much current as that required by ordinary incandescent lamps having half their light output.

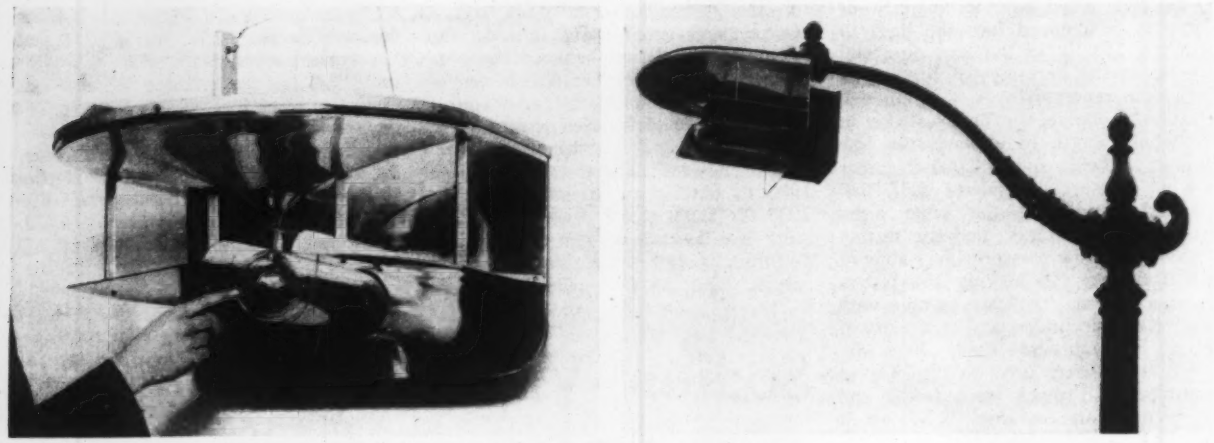
With the introduction of the new type of lamp, the installations also incorporate the first application of a reflector of decidedly different contours from those regularly employed for directing beams of light. The installations also mark the first commercial applications of a new kind of reflecting material, a specially treated aluminum that possesses high reflectivity and a hardened surface that successfully withstands weathering.

Merits of sodium lighting

A high luminous efficiency and soft diffused light of essentially a single color is produced by the new sodium-vapor lamps. Most of the energy output of the lamps is in the characteristic orange-yellow color of sodium, giving the lamp a greater proportion of visible light to other radiated energy than that obtained with other light sources. Forty to fifty lumens per watt of power consumption can be obtained in lamps having a useful life of 1,350 hours or more (commonly used incandescent lamps of comparable size generate 15 to 18 lumens per watt). Tests indicate that this quality of light aids definition of small objects

STREET LIGHTED with sodium-vapor lamps using a new type of reflector in which parabolic surfaces of specially treated aluminum direct the light across the roadway and along its length.





LIGHT STANDARD and enlarged view of sodium-vapor lamp with new type of reflector.

at low intensities to a greater extent than any other, including the white light or continuous spectrum of the incandescent lamp.

Installations made

At Revere, Mass., the new-type lighting units have been applied in the illumination of the cloverleaf intersection of the Salem Turnpike and Revere Beach Parkway, eleven of the units being employed. The lamps are along one side of the highway, between 200 and 300 ft. apart, and about 20 ft. above the road surface. Tests have shown that the curves can be driven with ease, even without headlights.

Ten units have been installed at Newton, Mass., for the illumination of a section of the Boston-Worcester Turnpike. These units, 140 ft. apart, are at a height of about 22 ft. Eight of the new lights are included in the installation at Wallingford, Conn., along Connecticut Route 5, between Hartford and New Haven. Here the units are 21 ft. high and 250 ft. apart.

At Schenectady, N. Y., where the first installation along a public highway was made last summer, the original units have been replaced by eight of the new 10,000-lumen units. These are along the Balltown Road, in staggered formation, 250 ft. apart and 23 ft. high. So that tests of sodium-vapor and incandescent lighting can be conducted, a 10,000-lumen incandescent lamp is also mounted on each of the poles. It is an easy matter to switch from one type of lighting to the other for comparative tests. The lamps that have been replaced with the new 10,000-lumen units developed 4,000 lumens and required both alternating and direct current. The new ones require only alternating current.

These installations all include a new type of sodium-vapor lamp, which, with an over-all energy input of 275 watts or less, produces 10,000 lumens. Incandescent-lighting installations require 550 watts for 10,000 lumens. The sodium-vapor lamp itself requires 240 watts or less, and the transformers and other equipment account for 30 to 35 watts.

The lamp itself consists of a long bulb of special glass inclosing at each end a coiled oxide-coated filament, which serves as a cathode, and an open-ended box of molybdenum, which serves as an anode. A small quantity of sodium and some neon gas are in the bulb, the neon being used to start operation. The lamp is about 16 in. long from tip to base, and about 3 in. in diameter. A double-walled evacuated flask of about 4 in. in diameter and 16½ in. in length is used with the lamp to retain the heat, which is essential for proper vaporization of the sodium.

Approximately 200 volts is required to strike the arc, after which about 27 volts is required to maintain the correct current. When the tube is cold, the application of starting voltage strikes an arc in the neon gas within the tube. The lamp then glows brilliantly with the characteristic red color of neon. Sufficient heat is soon stored up to vaporize the sodium, and the lamp gradually acquires the characteristic orange-yellow color of the sodium arc. About 30 min. is required to build up the sodium light to maximum output.

New type of reflector

The reflector used with the new type of lighting unit is outstanding because of its form and because it marks the commercial introduction of a new type of reflecting material. As shown by the illustration, the upper part of the highly polished unit resembles an airplane in its lines. Below this surface are polished fins, one on each side of and parallel to the light source. These fins and the parabolic cylindrical surfaces of the upper reflector direct the light along the length of the highway. The end of the upper reflector is also finished with a parabolic curve to direct the light across the highway. The fins redirect the light, which otherwise would escape upward beyond the edge of the upper reflector.

The reflectors are of aluminum, treated by a new process that hardens the surface, increases the reflecting power, prevents oxidation and makes the surface easy to clean. The new material, made possible by the development of the Alray process, is an exceptionally bright, durably finished aluminum with a reflection factor of more than 80 per cent.

Sodium-Vapor Lighting Studied for Midtown Hudson Tunnel

AN INVESTIGATION of sodium-vapor lighting, as a preliminary to its possible installation in the New York Midtown Hudson Tunnel, was begun last week by the Port of New York Authority, aided by the CWA, the United States Public Health Service, The General Electric Co. and the Westinghouse Lamp Co. The successful use of sodium-vapor lighting in the vehicular tunnel at Antwerp, Belgium, and on several highways both here and abroad, as well as the potential economy in power, led to adoption of the test program, which is largely directed toward the physiological effect of the light on persons working in it over a period of time.

In the investigation twelve employees of the Civil Works Administration will perform set tasks (tabulating traffic statistics) under sodium-vapor lamps for four hours a day over a period of three months, four hours being the length of time that tunnel policemen will be subjected to the lights. Another group of twelve employees will work at similar tasks under tungsten lamps. All members of the two groups will be examined at frequent intervals for visual acuity. The effect, if any, of passing from daylight into sodium lighting, and vice versa, is being studied also.

LARGE RETAINING-WALL TESTS

A series of five papers reporting fundamental results

II—Pressure of Saturated Sand

Lateral pressure of submerged sand fill is the full water pressure plus the lateral pressure of the solid fraction, allowing for the reduction of effective weight by buoyancy

By Karl Terzaghi
Professor, Technische Hochschule, Vienna, Austria

IN A preceding article (*ENR*, Feb. 1, 1934, p. 136) the author described the results of earth-pressure tests with dry cohesionless sand. The present paper deals with the results of similar investigations with cohesionless sand in a state of complete submergence. Equipment and testing material (Plum Island sand) were identical in both series of experiments.

Prior to filling the bin (14x14 ft.) the rear wall of the bin was lined with a gravel filter (Fig. 1). The fill was placed in 6-in. horizontal layers and compacted by concrete tampers. After the wall was allowed to yield through an average distance of 1.4 mm., or 0.055 in., by tilting as shown in Fig. 1, an intermission of 18 hours was introduced. Then the water was slowly admitted through the rear filter, gradually rising within the fill until it appeared at the surface. Twenty-one hours later the fill was drained and the wall was allowed to yield further, up to an average distance of 4.2 mm., or 0.17 in. After an intermission of 23 hours the state of saturation was reestablished without moving the wall. Forty-seven hours later the wall was moved out to a total average distance of 6.9 mm., or 0.27 in., from its original position. It remained in this position for a period of 23 hours while the fill was in a state of complete saturation, and for 5 hours more while the fill was in a drained state. The intermissions more than covered the period required for all the elements of the lateral pressures to attain practically constant values.

When draining the sand, almost the entire water contained in the voids of the sand flowed out, only thin films remaining on the surface of the grains; the water content of the drained fill was about 2.5 per cent of the dry weight, against 25 per cent for the saturated state.

Co-existence of sand and water pressure

The term "submerged" is confined to that state in which the horizontal surface of the fill coincides with a free water surface, i.e. when the water in a standpipe connected with the sand

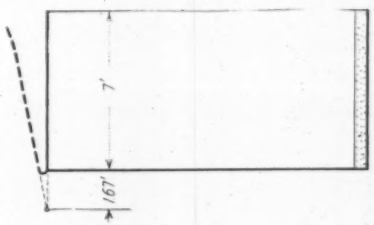


FIG. 1—GRAVEL FILTER at back of fill received water for submerging sand.

rises to the level of the surface of the sand. In such a state each sand particle is subject to the full hydrostatic uplift, which considerably reduces the active weight of the sand. Let

- s_o be the unit weight of the water,
- s the average unit weight of the sand grains,
- n the volume of voids of the sand, expressed as a fraction of the total volume,
- s_1 the specific gravity of the dry sand, and
- s_2 the unit weight of the sand reduced by the hydrostatic uplift.

The values s_1 and s_2 are determined by the known formulas

$$s_1 = s\ (1-n) \qquad (1)$$

$$\text{and } s_2 = (s - s_o)\ (1-n) \qquad (2)$$

Hence at any depth y below the surface of a dry backfill the load carried by the grains of the backfill per unit of horizontal section is $y \cdot s_1$, while in a submerged backfill the load carried by the grains at the same depth is equal to $y \cdot s_2$, which is considerably smaller. On the other hand, in a dry backfill the back of the wall merely receives the lateral pressure exerted by the grains of the backfill, while in submerged backfill the pressure exerted by the grains combines with the full water pressure. The presence of the sand has no influence whatsoever on the intensity of the water pressure. For the sand this entire independence between the action of the water and the sand was conclusively demonstrated for a horizontal cellar floor by the tests of H. de B. Parsons[1] and many others. Therefore, when plotting the results of the tests with submerged sand a clean-cut separation was made between the water pressure and the sand pressure.

Let s_o be the unit weight of the water. If the depth and width of the backfill are h and b respectively, the water pressure against the wall therefore is $W_o = \frac{1}{2}\ s_o\ h^2 b$. Deducting this amount from the total horizontal pressure H_o the horizontal pressure component due to the sand fraction of the submerged backfill become $H_2 = H_o - W_o$. Finally, if W_2 is the horizontal pressure that would be exerted by a liquid whose specific gravity is s_2 (see Eq. 2), the pressure coefficient of the sand fraction of the saturated fill is

$$k_o = \frac{H_2}{W_2} = \frac{H_o - \frac{1}{2}\ s_o h^2 b}{\frac{1}{2}\ h^2 b\ (s - s_o)\ (1-n)} \qquad (3)$$

The drained backfill, on the other hand, has a hydrostatic pressure coefficient of

$$k_d = \frac{H_d}{\frac{1}{2}\ s_1'\ h^2 b} \qquad (4)$$

wherein H_d denotes the horizontal component of the pressure and s_1' the specific gravity of the sand as moistened by the preceding saturation. In our case, owing to the fact that the sand retained but very little water, we obtained an average $s_1' = 1.025\ s_1$.

In similar manner the coefficient of wall friction was computed by means of the formulas

$$\text{saturated, } \tan \delta_s = \frac{V}{H - W_o} = \frac{V}{H_o - \frac{1}{2}\ s_o h^2 b} \qquad (5)$$

$$\text{drained, } \tan \delta_d = \frac{V}{H_d}. \qquad (6)$$

Test results

The results of the tests are plotted in Figs. 2 and 3. In all the figures the solid lines correspond to the drained state and the dotted lines to the submerged state of the backfill. The letters that refer to the submerged state are

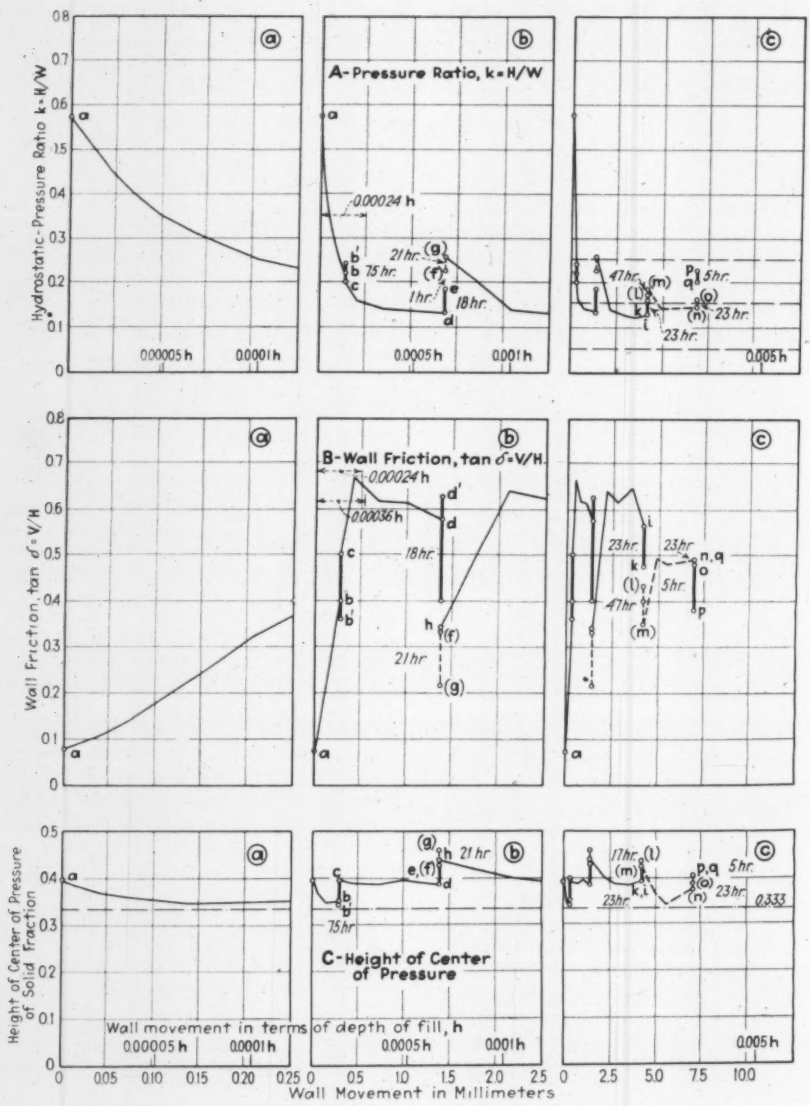

A-Pressure Ratio, k=H/W
Hydrostatic-Pressure Ratio k=H/W
B-Wall Friction, tan δ=V/H
Wall Friction, tan δ=V/H
C-Height of Center of Pressure
Height of Center of Pressure of Solid Fraction
Wall movement in terms of depth of fill, h
Wall Movement in Millimeters

FIG. 2—SUBMERGED SAND test results—Effect of wall movement on hydrostatic pressure ratio, wall friction and height of center of pressure of solid fraction of backfill.

shown in brackets. The changes that occur at a stationary position of the wall appear as thick vertical solid lines for the drained state and as dotted lines for the submerged state. The transition from one state to another is represented by gaps between vertical solid and dotted lines.

Fig. 2A shows the effect of the movement of the wall and of the processes of drainage and submergence on the value of the hydrostatic pressure ratio k. Abscissas represent the average distance through which the wall yielded. In Fig. 2B, the ordinates represent the tangent of the angle of wall friction (tan δ). In Fig. 2C the indicated position of the center of pressure is that of the solid fraction of the backfill only.

The diagrams of Fig. 3 correspond in every respect to the diagram of Fig. 5 in the preceding article. It should be noticed that the topmost curve in the diagram (a) of Fig. 3 of the present article is curved upward, while all the other ones are curved downward. According to the preceding article, the downward bend of the subsidence curve indicates that the corresponding point is located within the boundaries of the top surface of the wedge. Therefore, in the test now described the width of the wedge at the top must have been considerably greater than 710 mm., or 28 in.

Discussion of test results

Effect of Water on Internal Friction—In the preceding article the angle of internal friction which corresponds to the different stages of the test with dry sand was computed by means of Coulomb's formula. It was found that tan ϕ assumed its maximum value only after the wall was moved to a definite distance from its original position prior to the first slip. The relation between this maximum value of tan ϕ and the smaller values obtained in the test is the same as the relation between the ultimate shearing strength of a solid body and the shearing stresses associated with deformation with the limits of the ultimate resistance. Strictly speaking, therefore, the term "coefficient of internal friction" should be confined to the maximum value of tan ϕ, and it is used here merely for convenience. A better term would be "angle of active friction" or "angle of friction stress." If, for any stage of the earth-pressure test prior to the first slip the value of ϕ was found to be smaller than ϕ_{max}, we know that the strain in the backfill was less than that required to mobilize the entire frictional resistance of the material.

Table I contains a list of the computed values of ϕ for the different stages of the test in Fig. 2, together with the values of pressure ratio, wall friction, height of center of pressure, and elapsed time between consecutive stages. According to this table, the maximum value of the angle of internal friction is 47° for the drained state against 45°20′ for the saturated state, confirming the results of the friction tests, which showed that the presence of the water has practically no effect on the angle of internal friction. There is no contradiction between this fact and the well-known phenomenon of the "flowing out" of submerged sand fills, for the latter is a hydrodynamic phenomenon confined to fairly loose sand deposits and has nothing to do with the static internal friction. A discussion of the causes of the spontaneous spreading and flowing of submerged sand deposits can be found in one of the author's previous publications[3].

Effect of Depth of Fill on Internal Friction—Before the water was allowed to enter the dry backfill in the test diagrammed in Fig. 2, the wall had already moved through a distance of 0.00065h. According to the tests with dry sand described in the preceding paper, a movement through such a distance should be sufficient to mobilize the entire internal friction of the sand. For Test 1 with dry sand (preceding article) the value ϕ for a yield of the wall through a distance of 0.00065h was found equal to 52°20′, and the maximum value was 53°50′, against 45°10′ and 47°, respectively, found in the test described in this paper. Similarly the maximum value of the coefficient of wall friction was 0.75 for the dry sand against 0.66 for the saturated sand in Fig. 2, and the initial value of the hydrostatic pressure coefficient was 0.70 against 0.58.

These figures consistently demonstrate that both the internal friction and the wall friction for the present test (Fig. 2) were considerably lower

TABLE I — RELATION OF PRESSURE CONSTANTS TO YIELD OF RETAINING WALL

Distance of Yield of Top of Wall, Mm.	Condition of Backfill	Hydrostatic Pressure Coefficient k	Angle of Wall Friction $\tan\delta = V/H$	Angle of Internal Friction ϕ	Height of Resultant Pressure of Solid Part
	Dry (a)	0.575	0.08	14° 10′	0.396h
0.28	Dry (b)	0.219	0.40	36° 00′	0.349
	75 hr. later (c)	0.200	0.50	37° 20′	0.397
1.4	Dry (d)	0.133	0.58	45° 10′	0.387
	18 hr. later (e)	0.184	0.40	40° 00′	0.432
	Saturated (f)	0.225	0.34	36° 00′	0.433
	21 hr. later (g)	0.254	0.22	34° 00′	0.460
	Drained	0.234	0.42	34° 00′	0.420
	23 hr. later (h)	0.258	0.34	32° 20′	0.437
4.2	Drained (i)	0.127	0.57	47° 00′	0.394
	33 hr. later (k)	0.160	0.48	42° 40′	0.392
	Saturated (l),	0.163	0.44	42° 30′	0.436
	47 hr. later (m)	0.182	0.35	41° 00′	0.428
6.9	Saturated (n)	0.143	0.49	45° 20′	0.374
	23 hr. later (o)	0.161	0.48	42° 50′	0.388
	Drained (p)	0.225	0.38	35° 30′	0.411
	5 hr. later (q)	0.202	0.49	37° 00′	0.410

The letters refer to the letters in Fig. 2.

than those for the tests with dry sand. Both fills were made in the same manner (by compacting the material in 6-in. layers), and the average values of the volume of voids was found to be the same. The only difference between the fills resided in their depth, inasmuch as the depth of the present backfill was 7.0 ft. against 4.9 ft. in the dry sand test (Test 1) of the preceding article. This fact calls attention to the following important phenomenon:

For compacted sand under feeble pressure (smaller than about 0.1 kg. per cm²) the maximum angle of internal friction rapidly decreases with increasing surface pressures. For feeble surface pressures we lack a reliable method for directly determining the coefficient of internal friction. For the Plum Island sand in a compacted state tested under higher pressure, A. Casagrande obtained values of ϕ_{max} which ranged between 35° and 37°; in the tests of Fig. 2, the average normal pressure which acted on the sliding plane was 0.045 kg/cm² and ϕ_{max} was 47°; in Test 1 of the preceding article the normal pressure was 0.025 kg/cm² and ϕ_{max} was 53°50′; in previous earth-pressure tests on a very small scale with compacted sand 4 in. deep the writer obtained values of more than 65°. Hence the considerable depth of the backfill alone may account for the relatively low value of ϕ_{max} in Fig. 2.

In every other respect the fill had all the characteristic properties of a compacted backfill in contrast to those of a loose one— high initial value of k, a negligible value of the initial coefficient of wall friction, rapid decrease of k during the first part of the outward movement of the wall, a well-defined maximum for the coefficient of wall friction, and location of the center of pressure well above the middle third.

Effect of Wall Movement and of Intermissions—According to Fig. 2, in either the drained or the submerged state an outward movement of the wall increases the coefficient of wall friction and decreases the pressure ratio. During an intermission in the wall movement, the wall friction becomes smaller and the pressure ratio somewhat greater. In this respect there is no difference between the dry and the submerged sand.

Effect of Drainage and Submergence—The diagrams of Fig. 2 show that each transition from the drained to the submerged state, or vice versa, breaks the continuity of the curve and produces a rather substantial change of the stresses that previously existed in the fill. The accompanying table contains a list of related data. According to this table, after the wall yielded through an average distance of 1.4 mm., or 0.00065h, drainage of the fill caused a slight decrease of the pressure ratio combined with an increase of wall friction. As time went on, k slightly increased again, while the value of tan δ went down. In contrast to this, for a yield distance of 6.9 mm., or 0.0033h, the drainage process led to a substantial increase of k and a decrease of tan δ; but five hours later the value k had somewhat decreased, while the value of tan δ became greater than before. Hence the effect of drainage and submergence on the lateral pressure seems to depend on the distance through which the wall previously yielded.

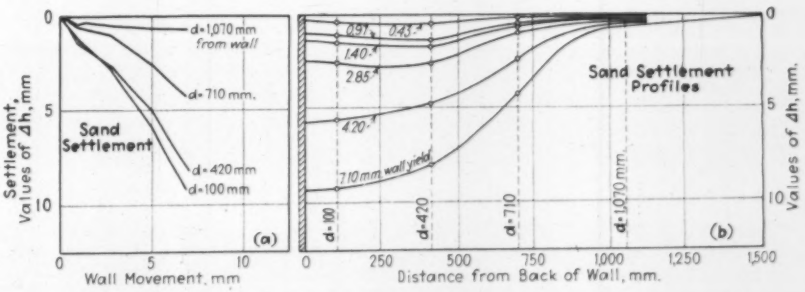
Effect of Drainage and Saturation on Density—The effect of drainage and submergence on the state of stress in the backfill is obviously due to minor structural changes essentially produced by the flow of water through the voids of the fill. This explanation is substantiated by the vertical movement of different points located on the surface of the fill. By means of such observations it was found that submergence invariably caused the surface of the fill to rise through a distance of about 0.5 mm., irrespective of the position of the wall. This was to be expected, because the hydrostatic uplift associated with submergence decreases the vertical pressure on the grains of the sand, and hence the fill expands upward. During this expansion the fill slides along the wall in an upward direction, which relieves the shearing stresses acting in the fill along the wall and causes a decrease of the wall friction.

On the other hand, drainage produced a subsidence larger than the preceding rise due to submergence, and the distance through which the surface subsided was different, depending on the distance through which the wall had previously yielded. Thus, when the wall was at an average distance of 1.4 mm. from the original position, drainage caused a subsidence of the top surface of the wedge through a distance of 1.0 mm.; after the yield of the wall was increased to 6.9 mm., drainage caused the top surface of the wedge to subside through a vertical distance of 5.0 mm.

This apparently insignificant fact throws light on the relation that was found to exist between the position of the wall with respect to its original position and the effect of drainage and submergence on the lateral pressure. With the wall close to its original position, the grains are still in stable relation, and drainage merely causes a minute subsidence of the fill in itself, which increases the coefficient of wall friction and reduces the hydrostatic pressure ratio k. But after the wall has approached the position corresponding to the first slip, the sand in the vicinity of the future sliding plane is stressed almost to the limit of what it can stand, and in this state any external cause, such as vibrations or the flow of water through the interstices, induces the grains to settle into more stable positions. The ensuing movement of the grains has the character of a spontaneous collapse, which in turn has the effect of substantially relieving the intensity of the stresses.

Distribution of Pressures Over the Wall—According to Fig. 2C, the center of pressure reached an average height of 0.4 h and was apt to rise as high as 0.46 h. An equally high position of the center of pressure was observed during Test 2 of the preceding paper,

FIG. 3—EFFECT of submergence and drainage on subsidence of fill.



where the wall was allowed to yield parallel to its original position. According to Coulomb, the center of pressure should be located at a height of 0.33 *h*, and, according to the advanced theories of curved sliding surfaces, at about 0.35 *h*. Yet none of the theories consider the important fact that the grain movements associated with the outward movement of the wall give rise to "arching" between the back of the wall and the inclined zone of maximum frictional stress. Arching relieves the stresses that act on the lower part of the wall and increases those acting on the middle part, as it does in the hopper bottom of a grain bin.

Unfortunately, due to the feeble pressures involved, the Goldbeck cells failed to inform us on the distribution of the pressures over the back of the wall. Nevertheless there can be little doubt that the distribution of pressures prior to the first slip is somewhat as represented in Fig. 4. This figure shows two mechanically and physically possible pressure distributions, for height of center of pressure at 0.40 *h*, (a) of Fig. 4, and at 0.46 *h*. The distribution at (a) in Fig. 4 approximately corresponds to state *d*, Fig. 2C and the straight dotted line shows the distribution of pressures according to the current Coulomb conception. At the upper edge of the wall the pressure curve is tangent to the Coulomb line, and the area included between the curve and the back of the wall is equal to the area of the Coulomb triangle. As a result of the grain movements during an intermission and subsequent submersion, the distribution (a) passed into (b) of Fig. 4, without the wall changing its position.

In order to account for the high position of the center of pressure without admitting "arching," one would be obliged to assume that the sliding surface has a far more important curvature than ever observed in tests with cohesionless materials, provided an explanation was possible at all. And if arching occurs, the lower part of the back of the wall cannot get more than a very low pressure. The static effects of arching on the lateral pressure were recognized as early as 1920 by H. G. Moulton[3] and by J. C. Meem[4] for cohesive materials, and our test results seem to confirm the conception also for cohesionless backfill.

These conclusions by no means deny the approximate validity of Coulomb's formula concerning the magnitude of the lateral pressure, because the equations for the equilibrium of the wedge are valid irrespective of the distribution of the pressures over the back of the wall and the sliding surface. In order to adapt Coulomb's theory to reality, one merely has to eliminate the conception of the triangular pressure distribution and the hypothesis that the angle of internal friction is necessarily identical with the angle of repose, a conception which was introduced into the theory by Coulomb's successors. Since there is no way to compute the arching effect on the position of the center of pressure, we are obliged to determine it by direct observation, as was done in the earth-pressure tests.

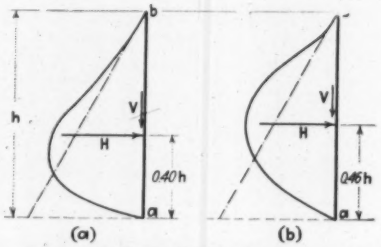


FIG. 4—DISTRIBUTION of pressure on back of wall for two positions of the center of pressure.

The preceding remarks concerning distribution of the pressures over the back of the wall merely refer to the conditions prior to slip. According to Tests 1 and 2 of the preceding article, slip causes the center of pressure to descend to a depth equal to or greater than two-thirds the depth of the backfill. The reason is obvious: at slip, the grains settle into more stable positions and the arches collapse, so that the Coulomb pressure distribution is reestablished at least approximately and temporarily.

In Test 1 of the preceding paper, the slip occurred after the wall yielded through a distance of 0.0027 *h*. In the present test no slip took place, although the wall yielded 0.0033 *h*. This failure of slip to occur seems to be connected with the fact that slip requires the material to be previously strained to the limit of its capacity, and as both drainage and submergence relieve the stresses in the backfill, the test represented by Fig. 2 gave no opportunity for stress to accumulate sufficiently for inducing a slip.

1. The lateral pressure exerted by the submerged backfill is equal to the sum of the full water pressure and the lateral pressure of the solid fraction of the fill, whose effective weight is reduced by buoyancy.

2. The presence of the water has practically no effect on the coefficients of internal friction and wall friction.

3. For a position of the wall in the immediate vicinity of the original one, the drainage of the fill produced a slight decrease of the hydrostatic pressure ratio *k* and an increase of the coefficient of wall friction tan δ. During a subsequent intermission, *k* increased and tan δ became smaller.

4. In contrast to this, after the wall moved beyond an average distance of one-thousandth the depth of the backfill, drainage produced an important increase of *k* and a decrease of the wall-friction tan δ. During the subsequent intermission *k* became smaller and tan δ greater.

5. Submergence causes a minute expansion, and drainage a more important subsidence of the fill. If the wall is close to its original position, the subsidence due to drainage is smaller than it is for more advanced positions of the wall.

6. The tests furnished indirect evidence for assuming that, prior to slip, the lower part of the back of the wall experiences lower pressure than the middle part, provided the wall is backfilled with compacted material.

References

[1]H. de B. Parsons, "Hydrostatic Uplift in Pervious Soils," *Trans.*, Am.Soc.C.E., Vol. 93, p. 1,317 (1929).

[2]K. Terzaghi, "Erdbaumechanik" (1925), p. 344.

[3]H. G. Moulton, "Earth and Rock Pressures," *Trans.*, Amer. Inst. of Min. and Met. Eng., February, 1920.

[4]J. C. Meem, "Pressure and Resistance of Soil," Brooklyn Engineers Club, February, 1920.

Storm Sewers of Creosoted Timber Built in Des Moines

TWO recently completed rectangular flumes for storm sewers in Des Moines, Iowa, totaling 1 mile, were made on the ground of creosoted timber prefabricated units 2 ft. and more in length. The top, sides and bottom were made up of 2-in. lumber built into laminated sections with tenons to match with each other at the ends. The timber strips were nailed together, the broad sides face to face, with 12d nails at 6-in. intervals. These strips were cut to the required shape and size and then were given an 8-lb. treatment of grade 1 coal-tar creosote by the standard empty-cell process. The top and bottom units were made up of strips of equal length but were put together with ends staggered to one-half the width of the side walls to match projecting tenons of the side units. These sidewall tenons were formed by square-cut shoulders half way through the width of the strip on every other strip. The flumes were 7x4½ ft., 6x4½ ft. and 5x4 ft. in cross-section. Twenty-one angles were necessary to allow the line to follow the natural drainage course and avoid trees. The few cuts that had to be made in the lumber after treatment were given field treatment with hot coal-tar creosote. The sections were interlocked by being forced together with heavy wooden mauls.

The project, which is described in detail in *Wood Preserving News* for January, was financed by the PWA. The flumes were designed and constructed by J. M. Tippee, city engineer of Des Moines.

Reconstruction in Long Beach Following the Earthquake

Repair methods used on various types of buildings, with an outline of the damage to structural frames, and figures on the volume of repair work and the method of inspection

By C. D. Wailes, Jr.
Formerly Chief Building Inspector Long Beach, Calif.

DURING the six months following the earthquake of March 10, 1933, at Long Beach 7,941 permits were issued by the city building department, totaling $4,757,000, for repairing the damage to buildings. The methods used in carrying out this repair and reconstruction program constitute a closing phase of the engineering review of the disaster, especially because the careful examination of structures required in connection with planning and executing repair work, revealed, in many cases, damage undiscovered during the previous surveys. In addition to describing repair methods, some figures on the extent of damage and the methods used in providing building department approval and inspection are included in this article.

Considering the hundreds of buildings repaired, it is possible to describe only typical methods used for the usual cases. For ease of classification and to make possible the correlation of this information with the previous article by the writer and A. C. Horner (*ENR*, May 25, 1933, p. 684), which reviewed the damage to buildings in various classifications as indicated by the initial survey, the following report will consider: (1) structural-frame buildings, both steel and reinforced concrete, (2) masonry bearing wall and wood-joist buildings, and (3) wood-frame buildings.

Structural-frame buildings

Structural-frame buildings, classified according to the Long Beach building code as "fire-resistive (concrete or steel frame)—Type I," included reinforced-concrete or steel construction fireproofed with concrete, clay tile or brick. Floors were of reinforced concrete, generally of concrete-joist construction built with removable metal pans, although there were some solid two-way slab and some solid beam and girder construction. Exterior walls, when of reinforced concrete, were about 8 in. thick, poured monolithic with the column fireproofing. The horizontal pour lines were at the tops of floor levels and the under side of spandrel beams. Brick or tile walls were generally 12 in. thick, either solid brick or combination tile and brick.

Masonry filler or panel walls were generally just "set" into the surrounding frame without any form of ties into the framework. Interior partitions were generally of 4- or 6-in. hollow clay tile, with elevator shafts and stair wells inclosed with 6-in. tile. Stairs were generally of reinforced concrete with one intermediate landing. Most of the buildings rest on spread footings with soil pressures varying from 4,000 to 8,000 lb. per sq. ft., although some rest on piles.

Damage to this type of construction by the earthquake of March 10 consisted of loosening the panel or filler walls, and cracking or displacing the partitions, particularly around stairs, elevator shafts, pipe chases, etc. Very little foundation damage was noticed. Buildings were plumb within allowable limits, and no excessive settlement was apparent. Concrete stairs generally were broken, as if they had acted as diagonal bracing between floors.

In the structural-steel frames very little damage was found, and this was generally confined to secondary bracing members.

FIG. 1—REPAIR WORK on spandrel beams and walls, indicating locations of cracks and material removed prior to rebuilding with gun work.

Reinforced-concrete frames were damaged mostly at the junction of beams and columns (Fig. 1). Spandrel beams were broken in various places, but generally within a third of the span from face of column. These spandrel cracks generally continued from window head to window sill above. Lack of continuity, insufficient anchorage and misplacement of reinforcing steel contributed largely to these failures. Construction joints were generally so poor that movement along most of them was quite apparent.

In the program of repair or reconstruction required in this type of structure, panel or filler walls of unit masonry, which had become loosened in the surrounding frame, were generally tightened by re-laying the brick around the edges and dry-tamping with cement mortar. Where the surrounding frame was of concrete, or of steel encased in concrete, some of the walls were keyed in by removing sufficient bricks to form a 4-in. key around the edge of the panel and filling this recess with a cement gun, making a wedge-shaped key and bonding the wall to the frame on all four edges of the exterior surface.

Where the wall was of tile or brick which had become broken or loosened badly, recesses were cut into the wall, making about one 12x12-in. recess per square yard of wall surface. The recess was deep enough to allow the gun work to bond to the inner course of brick or tile. The exterior of the wall was then covered with wire mesh, and about 1½ or 2 in. of gun work was shot over the old panel, bonding to the frame.

Loosened stone or terra cotta was replaced and grouted back. In some cases a small pressure gun similar to an automobile grease gun was employed to force grout into cracks. Additional anchorage was provided in nearly all cases.

Cracked Beams—Cracked or fractured beams gave rise to considerable difference of opinion among engineers as to methods of repair and relative seriousness of the damage. In nearly all cases even hair cracks were found to go entirely through the member. There was apparent loss of bond in many cases caused by the very close spacing of beam and column bars, which were often so close together that they formed a cleavage plane between the concrete core of the structural member and the fireproofing. In general, cracked or shattered portions of members were shored up, cut away (Fig. 2), and the members rebuilt with gun work, which averaged a strength of about 4,000 lb. per sq. in.

In chipping and preparing these structural members for the gun work, the cracks were cut out so that the cut was in the shape of a V with an angle

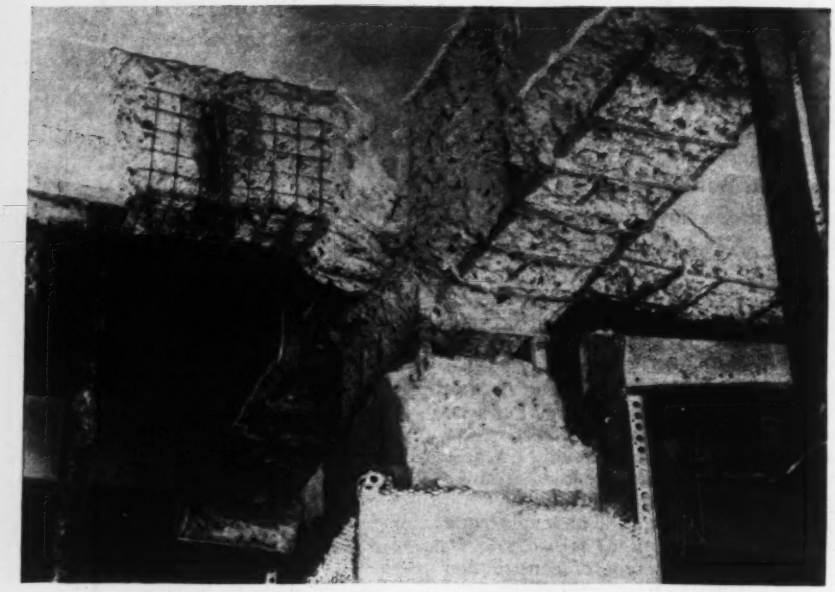


FIG. 2—LAITANCE and debris in the construction joint between column and beams resulted in fracture which was repaired by removing material as shown and rebuilding with a gun.

of about 90 deg. Care was taken not to strike the reinforcing steel with the chipping hammers, for it was found that if the bars were vibrated with chipping hammers the bond was broken. After using chipping hammers, the surfaces were gone over with light hand-hammers and all loose pieces removed. Surfaces were then cleaned with compressed air and water and filled with gun concrete, generally mixed in the proportions of 1 part cement to 4½ of aggregate.

The gun work was applied in layers, care being taken to prevent rebound pockets or slump cracks. It was kept covered with wet burlap for about seven days. Air pressure was specified to be not less than 35 lb. at the nozzle, and water pressure about 55 lb. Nozzlemen were checked carefully and in some cases examined to determine their fitness for the work.

Fractures in beams were divided into three classifications:

Type 1—Fractures within the middle third of the span with no spalling. This type of failure was repaired by making a V-cut one-third the width of the beam on both sides and across the soffit, and filling with cement-gun work.

Type 2—Fractures outside the middle third but not closer than one-tenth the clear span to the column. These beams were required to be cut completely through along the cracks. The beam was then wrapped with 2-in. electric-welded fabric extending the fabric at least 6 in. beyond the limits of the V-cut. The cut and the fabric were then shot with cement-gun work, and the fabric was covered to a depth of at least 1½ in. If the fracture had resulted from deficient steel, stirrups or longitudinal bars were added as required.

Type 3—Fractures nearer than one-tenth the clear span to the support. In this type of failure it was assumed probable that there had been bond failure in the bottom bars due to the fact that most of the bottom bars were stopped at the center line of supports. Reversals of stress probably caused bond failure and slippage of bottom bars. Insufficient top steel also resulted in negative moment cracks. Repairs to this type of failure were performed in a manner similar to the repairs on Type 2 failures, but additional steel was required to be added in the bottom of the beam extending around the column core or into adjacent beams sufficient to develop the bars.

Cracked Columns—Fractures in concrete columns were also classified in three groups:

Type 1—Horizontal cracks through column with no spalling or displacement. In this type of failure an examination was made to determine the possibility of a horizontal pour joint which might be padded with laitance or debris. If a joint was found, it was chipped out and the recesses filled with a cement gun. If the core was in good condition and only the fireproofing was damaged, a V-cut was made to the core and refilled.

Type 2—Failures of this class consisted of diagonal cracks through the column. In many instances where the column included a core with proper reinforcing spiral, the diagonal cracks did not go through the core and it was necessary only to remove the broken concrete to the core and replace. Where the diagonal cracks extended entirely through the column, as they did in many cases where the columns were banded, the column was required to be shored up, the entire cracked area cut out (th two cuts finishing as two flat cones wit points toward each other), addition steel inserted and spliced, and the co umn rebuilt with gun work.

Type 3—This group included all co umns where the cores were found t be shattered. In these cases the repa consisted of a complete removal of sha tered concrete, the insertion of ne verticals and the rebuilding of the co umns with gun work.

Concrete filler walls, where fracture were assumed to have acted as a majo stiffening element. Here the crack were repaired by making a V-cut (Fig 3) through the wall and refilling wit gun work. In some instances the V cuts were extended only one-third through the wall, and a layer of gu work of the proper thickness was ap plied over the entire panel, using welde fabric as reinforcing.

A type of repair and strengthening that was quite popular consisted of cutting horizontal chases into the exterior faces of spandrels and inserting new reinforcing bars a few inches below the window-sill line, the effect being to create a spandrel beam of greater depth, reinforced top and bottom. These bars were carried continuously around corners.

Masonry wall buildings

Buildings of the masonry bearing-wall type, classified by the code as "ordinary masonry (wood joists and masonry walls)—Type III," usually had interior floor and partition construction of wood carried on either bearing partitions or (occasionally) on steel beams and columns. In general, the walls bore the brunt of the shock and consequently were more seriously damaged than the interior framework. The structural repair work, therefore, was mainly confined to the walls.

Unit masonry of good quality with full joints and rich cement mortar generally failed in typical diagonal fractures, and the breaks followed generally straight lines, breaking bricks and mortar. Where repairable, this type of failure was generally repaired by relaying the masonry along the line of fracture, dry-tamping the top joints. In some instances a system of tension ties or keys, consisting of concrete or gun-work members extending about 2 ft. beyond each side of the crack and reinforced with several ⅜-in. bars, was used (Fig. 4). These ties extended about two-thirds through the wall and were generally placed about 4 ft. apart along the line of fracture. The fracture between the ties was opened about 4 in. deep and filled with gun work. In applying gun work to clay masonry it was necessary to wet down the masonry carefully and to be scrupulously attentive to curing.

Horizontal cracks extending along the entire length of a wall were very numerous. These, in general, were repaired

by replacing a 2-ft. section entirely through the wall and extending about two bricks above and below the crack, dry-tamping the joint tops. These keys or plugs were placed about 3 or 4 ft. apart in the clear.

Where the mortar was inferior and joints only partly filled, lines of fracture generally followed the mortar joints, rarely breaking the masonry units. Many of these walls were found to be shattered so that, although in many cases no cracks were visible, the bricks could be lifted out by hand. Such walls, and those found to be badly out of plumb, were not permitted to be repaired and were ordered demolished.

Walls of poor quality, yet not shattered, were repaired by methods previously outlined. They were reinforced on the exterior with welded wire fabric and covered with 1½ in. of gun work (Fig. 5). Keys were provided at 3-ft. intervals each way so that the gun work would bond to the inner courses of masonry.

In carrying out the repair program, reinforced-concrete vertical ties were installed in walls at regular intervals and at corners. Horizontal ties were used at floor and roof levels, and the floors and roof framing were anchored to the tie beams. These ties or bond beams were generally of poured concrete or gun work. Parapet walls were generally omitted on street fronts, but, where reconstructed, they were of reinforced masonry, concrete or gun work over a metal frame, the parapet being designed to act as a vertical cantilever from the horizontal tie beam.

Wood-frame buildings

Damage to wood-frame buildings (code classification, Type V) was generally limited to plaster cracks and fallen chimneys, if the structures were of well-braced wood-stud construction. Masonry veneer was loosened and generally had to be removed. Many of the older buildings were not well braced, and these suffered distortion; those constructed on short crippling studs or underpinning studs that were unbraced were shifted from their foundations.

Repairs generally consisted of replacing the building on its foundations, properly bracing the underpinning, repairing the plaster and reconstructing the chimney. Clay roofing tile was loosened and had to be relaid and nailed where it had been previously laid in mortar without nailing.

The Long Beach building department, in addition to enforcing ordinances that established minimum requirements for repairs, attempted to insist that certain buildings of a public nature, and others that had proved particularly vulnerable, should be strengthened and made more resistive to earthquake forces. In this the department was fairly successful, and many buildings were not only thoroughly repaired but were strengthened against possible future earthquake shocks. However, there were many buildings, particularly of the masonry-wall type of construction, which were given only the minimum repair permissible. The writer is doubtful of the efficacy of the repair work in some of these cases.

Cracking Continues—There were many aftershocks following the March 10 earthquake, and another rather severe shock was experienced Oct. 2. Continued inspection of a large number of buildings has revealed the fact that new cracks have opened. Sometimes these cracks are close to and parallel with the original fractures, but in other cases they were entirely new.

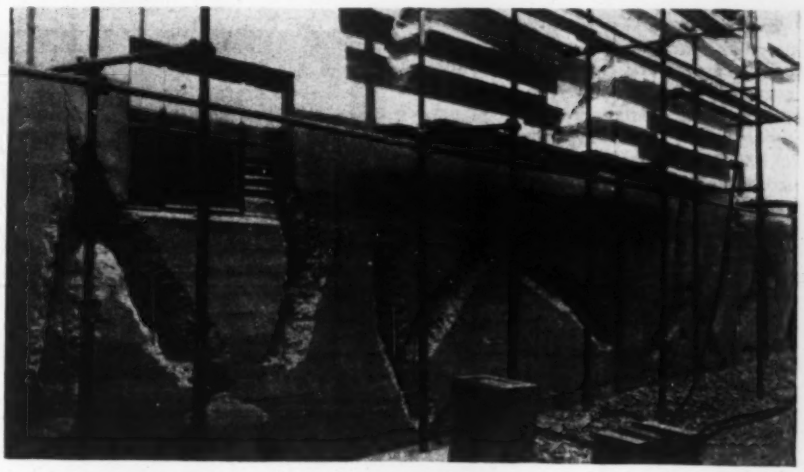


FIG. 3—TYPICAL DIAGONAL CRACKING in a concrete wall, trimmed out to a V-cut before filling.

Apparently the buildings, in attempting to regain a state of complete equilibrium, are continuing to move. In some of the multistory structural-frame buildings many new fractures have been noted higher up in the buildings. These have become apparent since the original fractures in the lower stories were repaired. It is possible that they were there at the time the other portions were repaired and simply were not discernible. Possibly by the repair and resulting stiffening up of the lower levels of the structure the points of contraflexure for the building may have been changed and these cracks made to open under the natural vibration of the building. Progressive settlement and expansion and contraction, with resulting grinding of mortar particles in the cracks, have no doubt contributed to this additional damage, which continues to be reported.

Department organization

As a result of lack of building activity, the Long Beach building department had been reduced in personnel until, at the time of the earthquake, the total personnel in the building and plumbing department was about ten. Following March 10, it was of the utmost importance to check all important buildings as rapidly as possible, and as a result the personnel of the department was expanded almost overnight to include about 100 engineers, architects and inspectors. The Architectural Club of Long Beach organized a branch bureau of inspection about ten blocks out from the center of the business district, and from there checked and reported on several thousand buildings.

The building department staff of about 100 systematically checked buildings in the downtown areas. Where these were found dangerous for occupancy, guards were stationed. The inspectors worked in groups under a captain, going over the downtown area by districts with the captains rechecking questionable buildings and reporting completely to the department twice daily. The first inspection was to determine whether the building was (1) safe for occupancy, (2) safe after minor repairs or shoring, or (3) entirely safe.

Names of buildings found safe were posted on bulletin boards and published in the papers. In each district the more important buildings—such as hospitals, mortuaries, drug stores, public-utility buildings, food stores, apartments and hotels—were checked first, leaving other types of occupancies to be checked later. Orders were issued forbidding public assembly under roofs until careful investigation of the buildings could be made and until the more severe aftershocks had subsided.

It was necessary to recheck buildings constantly, as subsequent shocks continued to increase the damage. Repairs using masonry, concrete, plaster, etc., were forbidden for about a ten-day period following the earthquake, although temporary repairs for protection of people or chattels were allowed to be made of wood, roofing paper and other temporary materials.

FIG. 4—METHOD of introducing keys of gun work across cracks in brick wall.

The task of the building department was made doubly hard by individuals who desired to seize upon the emergency as a means whereby they could break leases, collect insurance and accomplish various other objectives. It was necessary for the department to be extremely careful and act entirely independently of outside influences in passing upon the condition of buildings and in issuing various opening and closing orders. The writer, as chief building inspector, was reported to the governor of the state by the proprietor of a small tailoring shop because he had permitted a drugstore in an adjoining building to open and had refused to allow his tailoring shop to open.

By the end of March (three weeks after the earthquake) 3,665 permits, totaling $1,071,010, had been issued, and by the end of October, 8,830 permits with a total of $5,610,160 in valuation. Within this number of permits there were 889 new buildings valued at $853,050, leaving a net repair valuation of $4,757,110 for 7,941 buildings. This probably represents about 65 per cent of the private repair work which ultimately will have to be done and which at present is being withheld because of lack of finances or awaits settlement of insurance adjustments. The total does not include the repair or restoration of public buildings or schools, which will probably approach $6,000,000. In addition, many damaged buildings were razed, and no reconstruction has been started to date.

In nearly every case the cost of repair ran from 10 to 50 per cent more than was estimated at the time the permit was obtained, with outstanding cases running 100 per cent over the permit valuation.

Laws were passed permitting a reduction in assessed valuation of the buildings when proper claims for such were filed with the assessor. Check surveys made by the building department show in nearly every case that the claim of damage filed exceeded the permits obtained, and the department is now requiring the owner to obtain additional permits so that the records may be correct.

Assuming the permit valuation to be 20 per cent below average cost of repair, the amount expended for repair work up to Nov. 1, 1933, would be about $5,750,000. This is estimated to be 65 per cent of the total private repair work necessary, bringing the latter to about $9,000,000. To this figure should be added the repair work necessary to public buildings and schools, estimated at $6,000,000; razed buildings not reconstructed to date, $1,000,000; and repair work done in small amounts not requiring permits, such as minor plaster repairing, repainting and decorating, reglazing, etc., estimated at $2,000,000. This is obtained in a total figure of about $18,000,000, representing the damage to buildings in Long Beach exclusive of damage to equipment, contents or utilities.

It would be difficult to estimate just what percentage of this amount could be considered as representing actual minimum earthquake repairs, for in most instances the buildings were altered and improved and generally modernized, particularly as to exterior appearances.

The various demands for legislation requiring earthquake-resistant design have been answered by several new laws and ordinances now in effect. The new state law known as the Riley Bill requires that all buildings be designed for either a 2 per cent seismic factor or a 20-lb. wind, whichever causes the largest stresses. This law is enforced by the various building departments throughout the state. By another piece of legislation the state division of arch-

FIG. 5—MASONRY-WALL REPAIR effected by removing a course or two of brick, reinforcing with bars and fabric and rebuilding with gun work.

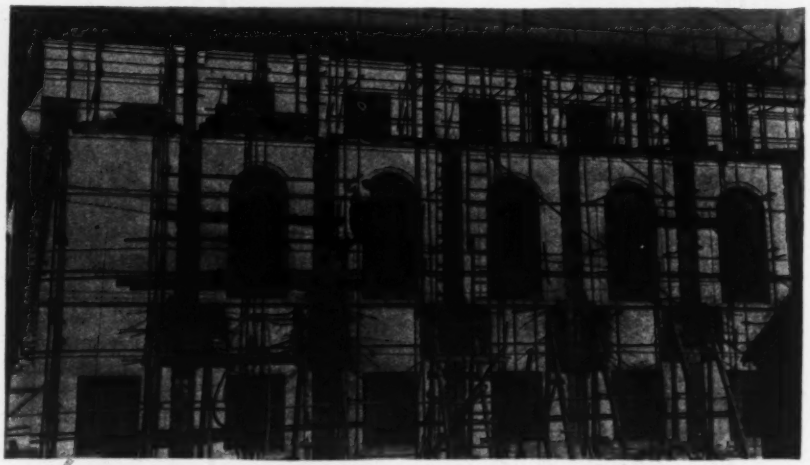


FIG. 6—THE EXTENT OF REPAIR WORK required on the walls of some of the larger masonry buildings is shown. Removal of bricks provides for introducing columns and horizontal tie beams.

itecture is given the authority to prescribe rules and regulations for the design and construction of all public schools. Among the various code provisions set up by this division is the requirement that schools be designed for seismic factors ranging from 2 to 10 per cent of the vertical load of the building, depending upon soil conditions and type of construction used.

New ordinances in Los Angeles, Long Beach, Los Angeles County and various other communities of southern California require that buildings be designed to resist a horizontal force of 8 per cent of the weight of the building, the weight being taken as total dead plus 50 per cent of the design live load. Public schols and the larger private schools are all required to be designed for a factor of 10 per cent. An increase in working stresses of 33⅓ per cent is generally permitted for horizontal force design.

Ordinances governing masonry construction have been revised in more detail, requiring richer cement mortar, more header courses and better workmanship. Wherever the repair or rebuilding work was at all complicated or involved repair of masonry or concrete, the building department at Long Beach required all this type of work to be done in the presence of a registered inspector employed by the owner and deputized by the building department. The department did not release the building for occupancy until the registered inspector signed a certificate of completion in which he stated that the work was done according to plans and specifications and in accord with building department ordinances and rulings.

The regular staff of the department was maintained at around 30 for six months. Plans were required for all structural-frame, masonry-wall and frame-building repairs, and all of the existing damage was required to be shown, so that a record of such damage would be available and could be used for future checking of the buildings.

When plans were submitted for permit, the structural engineer plan-checker would take the plans, visit the building and carefully check plans against the building, noting damage not shown. After all damage was properly shown on the plans and agreement reached on the repair detail, the permit was issued. Regular inspections were made by the various inspectors, and no plaster or paint was allowed to be applied until the approval of the inspector was obtained on all repair work where masonry or concrete was involved. In addition to periodical inspections, special inspectors trained in such work were sent to the job at intervals, and after all work was completed a final inspection was made and a certificate of occupancy issued.

The Structural Engineers Association of Southern California and the Long Beach Club furnished engineers and architects to assist the department, and much credit should be given both organizations for their valuable assistance. Future disaster-relief plans should include a very definite program in which these two professions should function, for their ability and service were well proven in the Long Beach disaster.

In spite of the fact that there were thousands of damaged buildings, and that tens of thousands of interested and curious persons constantly thronged the city, there have been no injuries or casualties to the public since March 10. This record has resulted from the combined activities of the demolition crews, inspection forces and the fire department, and the excellent guard and police work performed by the Navy, Army, Reserves and the police department.

Letters to the Editor

Elements of the Roughness Coefficient

Sir—The study by Robert E. Horton of the effect of separate roughness coefficients for channels (*EN-R*, Nov. 30, 1933, p. 652) is of great interest to hydraulic engineers and is suggestive of experimental work that might be made in the determination of the elements of the roughness coefficient and in reconciliation or elimination of inconsistencies.

Following the line of Mr. Horton's reasoning, a more general formula than Eq. (10) of the article is arrived at in a more comprehensive form, for any number of proportions of wetted perimeter of various degrees of roughness.

$$n = (n_1^{3/2} k_1 + n_2^{3/2} k_2 + n_3^{3/2} k_3 \ldots\ldots + n_e^{3/2} k_e)^{2/3} \qquad (1)$$

where n is the mean Manning coefficient, n_1, n_2, n_3 . . . n_e are the coefficients for various portions of subdivisions of the wetted perimeter and k_1, k_2, k_3 . . . k_e are the proportional parts of the whole perimeter to which these coefficients apply. For the same example as given in the article, for $D = 3.33$ and $L = 10.00$; $k_1 = 6.66/16.66 = 0.40$, and $k_2 = 10/16.66 = 0.60$, $n = (0.6 \times 0.025^{3/2} + 0.40 \times 0.012^{3/2})^{2/3} = 0.0206$. An analysis of the problem through a different method of reasoning indicates that Eq. (1) and likewise the formulas given by Mr. Horton may not give the true equivalent roughness coefficient. Formula (5) as derived below gives a value of $n = 0.0174$ for the example given in the article rather than $n = 0.0206$.

For a better understanding of the elements of the problem we may take the simple case of a circular conduit flowing full. Assuming the radial division lines between the sectors as bounding the area but of no effect as wetted perimeter, the hydraulic radius of any sector of any proportion of the whole area and of all the sectors is the same as that of the whole area of conduit, namely, one-quarter the diameter. It may be assumed that the retarding influence of these sectors on flow is proportional to the perimeter arc boundary of the sector and to the roughness coefficient of this arc perimeter and to the area subtended by this arc. This follows from the general laws upon which the accepted flow formulas are based.

For sector 1 the velocity by the Manning formula is $v_1 = \frac{1.486}{n_1} r^{2/3} s^{1/2}$, and for sectors 2, 3 . . . the same with subscripts 2, 3 . . . e. The mean weighted velocity of the sectors is the additive separate velocities, each in proportion to the separate wetted arc perimeter of the sector, and is equal to the mean velocity v as regularly determined as follows:

$$v = k_1 v_1 + k_2 v_2 + k_3 v_3 \ldots\ldots + k_e v_e \qquad (2)$$

where k is the proportion of the separate arc perimeters of sectors to the whole perimeter. Substituting in the Manning formula, we obtain

$$\frac{1.486}{n} r^{2/3} s^{1/2} = k_1 \frac{1.486}{n_1} r^{2/3} s^{1/2} + k_2 \frac{1.486}{n_2} r^{2/3} s^{1/2} \ldots\ldots + k_e \frac{1.486}{n_e} r^{2/3} s^{1/2} \qquad (3)$$

Canceling the constants 1.486, r and s, r being constant as demonstrated above,

$$\frac{1}{n} = \frac{k_1}{n_1} + \frac{k_2}{n_2} + \frac{k_3}{n_3} \ldots\ldots + \frac{k_e}{n_e} \qquad (4)$$

where n is the mean equivalent coefficient of roughness. From which for two sectors,

$$n = \frac{n_1 n_2}{k_2 n_1 + k_1 n_2} \qquad (5)$$

and for three sectors

$$n = \frac{n_1 n_2 n_3}{k_3 n_1 n_2 + k_1 n_2 n_3 + k_2 n_1 n_3} \qquad (6)$$

Likewise the same form in symmetry for any number of sectors.

These formulas hold on the same line of reasoning for any shape of open or closed conduit or channel if it be assumed that the velocity and energy of the water is affected in proportion to the length of perimeter of various and separate roughness coefficient; that is, that the separate hydraulic radii be such that the subtended areas are proportional to the separate lengths of perimeter, in the same way that the areas of the sectors in a circular conduit are proportional to the arc perimeters. In this light, formulas (4) to (7) are general.

In the case of the Chezy formula or the exponential formulas, such as Williams-Hazen and Scobey, the mean or equivalent retardation coefficient determined by the same method is

$$C = k_1 C_1 + k_2 C_2 + k_3 C_3 \ldots\ldots + k_e C_e \qquad (7)$$

Formula (7) is a more general form than (4) since Manning's formula may be adapted to the Chezy formula where $C = \frac{1.486}{n} r^{\frac{1}{6}}$ from which formula (4) is obtained by canceling 1.486 and $r^{\frac{1}{6}}$. Likewise, Kutter's formula may be adapted to formula (7), the factor r (hydraulic radius) in the denominator being given the value of that for the whole section of the channel or conduit.

It will be noted that the hydraulic radius or its influence do not enter into Eq. (4) to (7), except when adapting Kutter's formula. Also, that Eq. (4) derived by the writer is a reciprocal form of Eq. (1) derived on the basis of Mr. Horton's method.

Palo Alto, Calif., Dec. 22, 1933. W. BRUCE MCMILLAN.

Wanted—A Highway Association

Sir—I have just read the editorial which appeared in the *Engineering News-Record*, Feb. 1, 1934, p. 151, entitled, "Wanted—A Highway Association," and am sorry that the *Engineering News-Record*, which has always been noted for its fairness and straight-thinking, should take the position that the American Road Builders' Association is ready to fold up. It is true that its activities have been curtailed due to lack of finances, but the same is true of practically every organization at the present time.

The American Road Builders' Association has for many years through its contacts with groups as well as individuals scattered throughout the country, been a very important factor in developing and disseminating useful and practical information along technical lines. In recent years its activities in the promotional field, particularly in connection with federal appropriations for highways, I believe speak for themselves.

Your statement that ". . . the long-established A.R.B.A. is disorganized to the point where morale and inspiration are all but gone"; and the further statement that "It may yet rally its forces effectively, but on present outlook the army must be created anew," should not presume the road builders are through. Why would it not be better to attempt to recreate the interest and support behind the association to accomplish the purpose which you have in mind in your editorial? It is true that it is now down to more or less of a skeleton organization but the contacts and the basic ground work are still in existence and it would seem to be logical that instead of this structure being scrapped it would be far better to rebuild it to a point of greater effectiveness than to attempt to form a new organization.

I am inclined to agree with you that no existing organization which represents only a fractional element of the field can be as effective on the public as something which takes in the broader field; however, the problem lies in the method of organization and support of the larger organization. I believe that the Road Builders' Association has in the past covered a broad field and that if its support could be drawn from additional fields, that it would be in an excellent position to carry on and do the real work which is required. It might possibly be that a parent organization of some kind would lend the proper color from the standpoint of its impression on the public but there is a serious question whether or not the real and necessary work could be effectively done in that manner. It is a difficult problem to sell the individual on supporting an organization unless he is vitally and directly interested in its activities. Everyone of course is interested in the use of highways but there are but few who are willing voluntarily to contribute anything in any form unless they are engaged in some line of busines which is directly connected with the program.

I really believe had you had all the facts before you, that you would have written in a different way. Considerable effort was made at Chicago to keep the organization going and I believe that something was accomplished. Your editorial, however, does not help that situation and it is my thought that the *News-Record* should lend its aid rather than to carry the impression which the editorial did.

H. G. SOURS,
President, County Division, American Road Builders' Association.
Akron, Ohio, Feb. 13, 1934.

W/C Ratio Not a New Idea

Sir—While some members of the profession may believe that moisture control in concrete is new, those who have been "in the game" since concrete first came into general use in this country will recall that the old-time specifications covered the point in a definite manner. It was not until the advent of reinforcing bars and intricate forms that anything approaching a sloppy mixture was permitted. In this connection, a description of some of the earlier works may be of interest.

In 1897 a contract was let by the Illinois Central Railroad for the construction of some "artificial stone" curbing. This was to be placed around a paved area between team tracks in a new yard at Louisville, Ky. Not long ago I was looking through some old records and discovered a diary in which some notes had been entered concerning this curbing, made while serving as inspector on the job. Only a few abstracts from the specifications were entered, those apparently being the ones which had impressed me the most. Drawing mainly from these notes, but partly from memory, it is recalled that the sand and cement were mixed dry "until they were of a uniform color," water was added to form a mealy mixture, and the mortar was then spread to form a bed of uniform thickness before the rock was added. Mixing was then resumed until the mass was again of a uniform color and appearance.

It is my recollection (though not supported by memoranda) that there were sixteen "turn-overs"—six of the sand and cement, five after adding the water and five of the complete mass. At any rate, it was not the 1-min. mix of modern times.

The specifications provided that the finished mixture should appear only slightly moist and that no free water should appear in a sample picked up in the hand until it had been patted vigorously.

Great stress was placed on the construction and bracing of forms, a wise provision as the material was placed in layers not exceeding 3 in. in thickness and rammed with a heavy iron tamper until water came to the surface. No steel was used in the concrete curbing either as reinforcing or in the form of protecting armor.

On discovering this record I was curious to learn how well the curb had served its purpose. This was made possible through the kindness of F. L. Thompson, now vice-president of the Illinois Central system. The following is quoted from a reply to an inquiry addressed to him:

"I had an inspection made to determine the condition of this curbing upon receipt of your letter and find that there are approximately 2,280 ft. still in place, the balance, or 320 ft. having been replaced with stone curbing.

"The concrete curbing is in fair condition and shows very little disintegration. There are of course a few places where it has broken down, probably caused by wagon wheels bumping against it."

This work was done 36 years ago, when the slump and other tests for concrete were unknown, but a good product was secured which withstood more than 20 years of terrific impacts from steel-clad wheels of heavy drays, though it is doubtful if much punishment now reaches the curbing. The overhang of body of the present motorized trucks and drays probably keeps the wheels well away from the curb.

ARTHUR M. SHAW,
Consulting Engineer.
New Orleans, La., Dec. 18, 1933

Book Reviews and Notes

A Monthly Commentary on Current Additions to the Civil Engineer's Library

❖ ❖ ❖

Fascinating Reading For Engineers

By Robins Fleming
New York, N. Y.

THE ELEMENTS OF EUCLID—Edited by Isaac Todhunter. Cloth; 4x7 in.; pp. 298; diagrams. Published as part of the *Everyman's Library* by J. M. Dent & Sons, London, and by E. P. Dutton & Co., New York. $0.70.

A RECENT ADDITION to *Everyman's Library* is "The Elements of Euclid." This book is heartily commended to every engineer with leisure time at his command. After reading the introduction by Sir Thomas L. Heath—a British mathematician of note and an authority on Euclid—he will be inclined to read the book without further urging. To quote Sir Thomas:

"Any intelligent person with a fair recollection of school work in elementary geometry would find it (progressing as it does by gradual and nicely contrived steps) easy reading, and should feel a real thrill in following its development, always assuming that enjoyment of the book is not marred by any prospect of having to pass an examination in it. This is why I applaud the addition of this great classic to *Everyman's Library*."

The text of Todhunter based on that of Simson (1756) is followed in the reprint. The logic is faultless. Each distinct assertion in the argument begins a new line; and at the ends of the lines are placed the necessary references to the preceding principles on which the assertions depend. These references are great helps to the reader in following the steps of the reasoning. Proposition 47, Book I, may be taken as an example. This is the proposition often associated with the name of Pythagoras. The translation given by Simson is:

"In any right-angled triangle, the square which is described on the side subtending the right angle is equal to the square described on the sides which contain the right angle."

Many proofs of this proposition based on the adamantine rock of Euclid have been published. The *American Mathematical Monthly*, Volumes III, IV, V and VI, 1896-1899, in a series of articles by Benjamin F. Yanney and James A. Calderhead, gives no less than 100 demonstrations. However, some of the proofs given are modifications of other proofs, and some are not purely geometrical.

The engineer is urged to read "The Elements of Euclid."

Miscellaneous Notes on Booklets and Reprints

A LIST OF AMERICAN STANDARDS approved by the American Standards Association, together with the prices of each separate item, has been published by the association, 29 West 39th St., New York City.

THE SUBJECT OF CONCENTRATED LOADS on concrete slabs is brought up to date in a paper by Prof. Clyde T. Morris, published as Bulletin No. 80 of the Engineering Experiment Station, Ohio State University, Columbus. Price 25c.

DATA ON RIVET BOLTS and bolts with self-locking nuts are given in the new 200-page Handbook published by the Dardelet Threadlock Corp., 120 Broadway, New York. Full information relative to design and application is presented.

A SUPPLEMENT to "Population Characteristics by Census Tracts," information for which was compiled in 1932 under the auspices of the *Cleveland Plain Dealer*, has been published by The Plain Dealer Publishing Co., 523 Superior Ave. N.E., Cleveland, Ohio. The earlier study was reviewed in *Engineering News-Record*, Feb. 9, 1933, p. 187.

CONCRETE ROAD DESIGN, SIMPLIFIED AND CORRELATED WITH TRAFFIC, is the subject of a new booklet prepared for the Portland Cement Association by Frank T. Sheets, formerly chief engineer of the Illinois state highway department. It discusses the design of pavements to meet various traffic conditions from lightly traveled roads to those in metropolitan areas. Copies of this booklet may be obtained from the Portland Cement Association, 33 West Grand Ave., Chicago, Ill.

COLLECTIVE BARGAINING UNDER THE N.I.R.A.; the result of a nation-wide survey of the extent to which employees have availed themselves of rights conferred by Section 7 (a) of the National Industrial Recovery Act is summarized in a pamphlet entitled "Individual and Collective Bargaining Under the N.I.R.A.," published by the National Industrial Conference Board, 247 Park Ave., New York.

PUBLIC HOUSING LAWS, a memorandum on the drafting of state enabling acts for public housing agencies, is available from the National Association of Housing Officials, 850 E. 58 St., Chicago. Free to public officials, 25c to others.

WHO SHALL USE THE HIGHWAYS AND HOW is the subject of a pamphlet being distributed by the American Association of State Highway Officials, National Press Building, Washington, D. C. The purpose of the pamphlet is two-fold first to counteract some of the statements made by railroad representatives concerning the size, weight and speed regulations proposed by the association for adoption as a uniform standard, and, second, to set forth the background of those regulations for the information of those called upon to consider their adoption.

New Books and Revised Editions

[Those desiring copies of the books listed below or mentioned elsewhere in this section should order them from the publishers or from their local booksellers.]

CREDIT MANUAL OF COMMERCIAL LAWS FOR 1934—Cloth; 6x9 in.; pp. 498; Published by National Association of Credit Men, New York. $4.00.

DYNAMICS OF EARTHQUAKE RESISTANT STRUCTURES—By Jacob J. Creskoff. Cloth; 6x9 in.; pp. 127; tables and diagrams. Published by The McGraw-Hill Book Company, New York and London. $2.50.

EXPLANATORY HANDBOOK ON THE CODE OF PRACTICE FOR REINFORCED CONCRETE—By W. L. Scott, W. H. Glanville, with a foreword by Sir George Humphreys. Cloth; 7x10 in.; pp. 158; tables and line drawings. Published by Concrete Publications, Ltd., London.

THE GREAT LAKES–ST. LAWRENCE DEEP WATERWAY TO THE SEA—By Tom Ireland. Cloth; 5x8 in.; pp. 223; photographs, maps. Published by G. P. Putnam's Sons, New York and London. $2.00.

MECHANICAL WORLD YEAR BOOK 1934—Cloth; 4x6 in.; pp. 361; tables and diagrams. Published by Emmott & Co., Ltd., 31 King Street West, Manchester, England. 1/6 net.

SAFEGUARDING INDUSTRY AGAINST THE PILFERING OF IDEAS—By Henry Creange. Cloth; 8x11 in.; pp. 65. Published by George Grady Press, New York. $1.50.

TESTS ON STRUCTURAL MODELS OF PROPOSED SAN FRANCISCO-OAKLAND SUSPENSION BRIDGE—By George E. Beggs, Raymond E. Davis and Harmer E. Davis. Paper; 7x10 in.; pp. 166; diagrams, tables and photographic illustrations. Published by University of California Press, Berkeley, California. $1.50.

LE TRACE DES RACCORDEMENTS PROGRESSIFS—By J. Lamoen. Paper; 6x9 in.; pp. 113; folding chart, tables. Published by Goemaere, Bruxelles, Belgium.

TRADE ASSOCIATIONS AND INDUSTRIAL CONTROL—By Simon N. Whitney. Cloth; 6x9 in.; pp. 237; tables. Published by Central Book Company, New York. $3.00.

ENGINEERING NEWS-RECORD

Volume 112, No. 8 *

Copyright 1934 by McGraw-Hill Publishing Company, Inc.

EDITOR—F. E. Schmitt. EDITORIAL STAFF—V. T. Boughton, W. G. Bowman, F. W. Herring, C. S. Hill, H. W. Richardson, W. W. De Berard, N. A. Bowers, J. I. Ballard.

Editorial and Publishing Offices at 330 West 42d Street, New York

February 22, 1934

Industry's Work Begins

SIGNING of the general contractors' code, Chapter II of the Construction Code, completes the first stage of enactment of the document which makes construction an operative entity. It is now possible to proceed with putting to effect the system of control of construction through registration of contracts and observance of fair trade practices, and also proceed with the planning of programs and employment conditions. Elimination of unhealthy competitive methods and vicious racketeering may thus be taken in hand at once. If the NRA does its part, the other chapters of the code should now follow quickly, so that the construction season may find the art and industry in good working order throughout. In view of the advantages accruing to every interest from the code, all hands will join in making the activities of the industry thoroughly sound in the shortest possible time. Fortunately the price-fixing problems that beset the administration of other codes do not enter; thus, as soon as the local bargaining groups can be set up and get into action in arranging wage agreements the system will be ready to go to work.

A Step Ahead

REVISION of the CWA wage rates, announced last week, removes one of the sources of trouble of a relief system that in its general effect is highly constructive. The CWA rates originally established, identical with those of the Public Works Administration, were based on the PWA acceptance of the union recommendation in favor of a fixed schedule of rates for all work financed from the $3,300,000,000 fund except where the law made specific exception, as in the case of the highway program. This agreement was made the excuse for carrying the PWA rates into the winter relief program, a step whose generally disruptive effect is well known and which lessened the number of men that could be employed and the length of time the work could continue. The lower rate set under the new order permits of sound progress of the program and leaves a natural opportunity for the progressive absorption of the workers by regular construction and business. The remaining item of improvement in the CWA system, to provide skilled planning and direction, still awaits action.

Old Evils Survive

EIGHT VICTIMS of a tenement house fire in New York on Feb. 17 are mute witnesses to the tragic effects of housing delays and civic laxity in action. The fire is chargeable to conditions and housing practices that for more than three decades have been recognized as bad and have been outlawed in new construction. Their survival for a limited time after the adoption of the Tenement House Law was natural, but that they should be allowed to continue in existence is hard to explain except on the basis of persistent official negligence coupled with over-great consideration for existing investment regardless of all else. That gross laxity in administration was no small factor in the matter seems clear from a statement of the Tenement House Commissioner that many thousands of violations of the provisions of the law have not been disposed of. The health and safety powers of public authorities are ample to give the means for wiping out antiquated and dangerous housing, and with the present number of vacancies in apartment buildings it is no excuse to say that closing the old rookeries would deprive people of needed living quarters. Courageous action in eliminating unsanitary or fire-dangerous buildings would do more than any other one thing to do away with slum areas and promote good housing.

Repairing Earthquake Damage

BUILDING REPAIR or reconstruction usually presents more complex problems and demands keener and surer practical judgment than the creation of new structures. The physical conditions on which the security of the work depends can rarely be measured or accurately appraised; the stability of the old wall and the strength of the joists is quite indeterminate, and how much bracing and stiffening is needed must be decided by practical sense alone. Difficult as these questions may be, they are made far more so by antagonisms and divergent interests of owner, lessee, mortgage lender and insurance company. A leading example of the resulting complications appeared in the work of the Long Beach building inspection department after the earthquake of March 10, when many hundreds of damaged buildings had to be approved or closed quickly, then repaired, reconstructed or torn down. C. D. Wailes' account in this issue of how this work was done is highly instructive. That strong differences of opinion arose is natural, indeed inevitable, considering the fact that interested parties were affected in the pocketbook nerve while the public representatives had to look first of all to substantial safety. The inadequacy of technical information also was bound to furnish ground for disagreement. But the promptness of the handling of the immense problem and the successful effort to effect rapid and impartial rehabilitation of the buildings is worthy of commendation.

Suspension Bridge Trends

A NOTICEABLE INCREASE of interest in short-span suspension bridges on the part of American engineers has been apparent over the past few years. This interest has been translated into relatively few actual structures, but it is significant nevertheless. In the first place, the successful development of high-modulus shop-manufactured cable strands removes many field difficulties inherent in field-spun cables. As a result, many contractors formerly not experienced enough to handle suspension bridges can now erect them easily and economically. What is perhaps even more important is the favorable effect that the designing and building of short-span suspension bridges should have on suspension bridge practice in general. More bridges would be built, and thus more engineers and contractors would be concentrating on questions of improvement in technique and practice. Furthermore, it is a fact that innovations or at least uncommon expedients are more likely to be tried on small structures than on large ones. For example, last year a self-anchored design was used on a 225-ft. span in Missouri, and stiffening trusses of rolled-section members were used on a 300-ft. span in the state of Wash-

ington. In this issue is described a 450-ft. span bridge of American design in San Domingo in which the cable saddles are sunk into the tower tops to reduce eccentric wind loads and an interlocking-steel-channel floor surfaced with asphalt plank is used for dead-weight reduction. All three of these bridges use open-type cables, a practice which has much to recommend it from the viewpoint of erection simplicity and economic construction. Even shorter-span bridges than any of these have been considered for several locations. The increasing interest in such structures should mean much to highway engineers especially.

Highway Stability and the A. R. B. A.

A COMPREHENSIVE association of highway interests is wanted to head up directed and organized activity in support of highway development, we said in these pages two weeks ago. Both supporters and critics of our position, even though they disagree with us on individual points, join with us in this broad conclusion. Indeed it thrusts itself deeply into the consciousness of every thinking observer.

The next twenty-four months promise to decide the question whether highway planning and financing shall go ahead on a stabilized basis or shall crumble under the attacks now being directed against it, to be rebuilt perhaps only after a long and wasteful delay. If stabilized highway development is to be restored the task is that of the highway and transport interests, for no one else will take it up. Let us glance at the facts.

The popular urge for improvement and extension of roads has been beaten down by depression unemployment and inability to pay taxes. State legislative activity is all turned to confiscation of existing road revenues. Federal action, which alone is directed to increased road improvement, is predicated on giving men work and not on stabilized development of improved highways; stripped of its unemployment-relief plumes the present federal highway dole is seen to be a naked, ugly emergency device. And, not least of the obstacles, the railroads under pressure of declining traffic have organized themselves as a pro-railroad and anti-highway force that operates to check transportation progress.

Under these conditions the highway and transport group must bring together all its elements into strong, virile union if it would ward off defeat of the highway movement. What shall be the scope and purpose of this union? Out of what shall it be created?

In scope, it is indisputable that this highway association must reach beyond the roadbuilding industries. Though road improvement is the element on which the highway business fundamentally depends, it includes only a small part of those who live and do business because of the highway. Beyond it lie the motor car and oil industries, the carriers and travelers—even the automobile club. All these come definitely within the comprehensive membership of an organization that shall truly represent the highway.

As to purpose, the very conditions of the existing crisis express it. The question is rather what mechanism is required for its effectuation. That mechanism, obviously, must provide for dealing with internal and inter-industry problems, for cooperation in technical study and promotion, for development of economic analyses and management policies. No less important is public education on both technique and economics of the improved road—the dissemination of facts concerning the highway business as a whole.

To perform these tasks effectively the association must have tools—data, statistics, and means of analytical research. A collecting agency even for mere roadbuilding data does not exist in the main, while the highway business as a whole has virtually no statistics whatever. The business lacks the most effective tool it could possess in clearing the way for understanding by public and legislatures. Technical research has progressed greatly in the last few years, but unless supported and intensified it will not long remain potent. And economic research still has to be built up from the foundation.

The long-time objective and the requirements of organization for permanent service are thus clear enough. But at the same time an immediate issue is with us, for the attacks that threaten to disintegrate road transport are powerfully active. Action therefore must begin even though final organization is not perfected. But the work of building the broad, strong highway association that the situation demands is the work of today even while the year's emergency activities proceed.

These comprehensive problems cannot be dealt with through any mere fractional representation of the highway business. It will not suffice to organize around an individual objective, however effective that may be for a restricted purpose.

In first line, the movement for an effective highway agency will look to the American Road Builders Association. Its long service and the strength that comes from being well known count heavily in its favor. But entire reformation of structure and spirit is necessary. In the past the organization has spent its energies largely in producing an exhibition of roadbuilding materials and machinery, and however successful it was in this attempt its structure disintegrated and its work swung so far from balance of interest and effort that virtual rebuilding is necessary. A paying membership has to be built up, direct member-support financing developed, and a definite program of activities prepared and budgeted. In addition, the technical activities of the association must be broadened to include all phases of road planning, construction and service.

Can the American Road Builders Association beget in itself the elements fundamental to that vigor which is now indispensable? Has the association the vision to see and the spirit to carry out the labor of recreation? Unless it has, it cannot measure up to the job that needs to be done, and it is sure to perish. If it has it must prove its intention and its faith by its works. Failing in prompt action it cannot ask that the highway business shall continue to wait in patience while it follows an opportunist course of leisurely reform.

Admittedly there is a present emergency task of defensive action, and in undertaking it the A.R.B.A. will have the support of engineer, official and manufacturer alike, for the menace to highway progress extends to every group. But what of the year beyond? What of the future? Unless the view is extended beyond the day's emergency to long-time needs, the present year's effort is in danger of being largely lost. Only by setting out at once to erect a unified industry association in which the views and power of all component interests may be brought to a focus can we assure the sound furtherance of the highway as one of the greatest tools of civilization's progress.

CURRENT NEWS

Contractors Code Signed by President Roosevelt

THE PRESIDENT on Feb. 17 approved Chapter II of the Code of Fair Competition for the Construction Industry, covering the general contractors division. It becomes effective thirty days after approval, or on March 19. This brings to successful completion efforts started even before the NIRA was passed last June. The initial draft of a general contractors code had been submitted to NRA before the Construction League began its efforts for a unified construction code.

The content of the general contractors chapter is substantially as previously reported in these columns (*ENR*, Feb. 8, 1934, p. 213). Provision is made for subdivisions of general contracting, indicating immediate establishment of a building contractor subdivision, a heavy construction and railroad contractor subdivision, and a highway contractor subdivision. Supplementary provisions may be added hereafter to Chapter II in sub-chapters, with the approval of the Administrator, to cover the specific requirements of such subdivisions, including any trade practices peculiar to such groups.

Members of the general contractors division are governed jointly by the provisions of Chapter I (approved Jan. 31) and Chapter II. The divisional code authority for general contractors will comprise seventeen members, twelve to be appointed annually by the executive committee of the Associated General Contractors and five to be appointed by the executive committee from employers not members of the A.G.C. A subdivisional administrative committee will be responsible for administering the code in each subdivision. Appeals from its decisions will be heard by the divisional code authority. Appeals from the divisional code authority, as is the case with all chapters of the construction code, will be carried to the construction appeals board to be established by the construction code authority established by Chapter I.

Copies of Chapter II—General Contractors Division, will be available in due course from the Superintendent of Documents, Government Printing Office, Washington, D. C. at 5c. per copy. Chapters I and II have been printed in one document by the Associated General Contractors and may be obtained at 222 Munsey Building, Washington, D. C. at 10c. per copy.

Printed copies of each chapter of the construction code are available also from the Construction League, 1741 New York Avenue, Washington, D. C. at 5c. per copy, per chapter. The League has printed the code in letter size (8½x11 in.) on heavy bond paper with headings inserted to assist the reader. Chapters I and II are now available but orders may be placed with the League for sending printed copies of other chapters as approved.

Government To Buy Neglected Land Adjoining National Parks

An allotment of $2,235,000 for the purchase of land for emergency conservation work in national park and national monument areas has been announced by the Public Works Administration.

Areas in which it is proposed to buy land are as follows: Great Smoky Mountains National Park, North Carolina and Tennessee; Shenandoah National Park, Virginia; Mammoth Cave National Park, Kentucky and Colonial National Monument, Virginia. Lands which have been acquired in these areas for national park purposes have been found to lack adequate protection from forest fires, floods, soil erosion and plant disease because of the proximity of neglected privately-owned acreage. These conditions are to be corrected by the acquisition of certain contiguous privately-owned land and by emergency conservation work.

A previous allotment of $1,550,000 for the purchase of land in the Great Smoky Mountains National Park area has been revoked by executive order.

Code Problems Conference To Be Held in Washington

Invitations to participate in a conference to be held in Washington March 5 to 8 to determine practical means to meet problems which have arisen in code operation have been forwarded by National Recovery Administrator Hugh S. Johnson to nearly 7,000 members of the authorities created under approved codes and to trade association code committees representing those industries whose proposed codes are now awaiting formal approval.

The major purposes of the conference, as outlined by Administrator Johnson, include "the consideration in public sessions of the possibilities of increasing employment; protection against destructive competition and against excessive prices and monopolistic tendencies; the elimination of inequalities and inconsistencies in codes; the position of small enterprises; and the vast problem of code administration and the organization of industry for self-government."

The Recovery Administration desires accurate information concerning the effects of codes on operations, including employment, price trends, unethical trade practices, as well as the effects of code provisions, if any, restricting production, and the effect of codes on smaller concerns. In addition the invitation solicits suggestions to be presented during the conference for the modification, elimination or addition of specific code provisions.

The general conference will be divided into several public group meetings to be followed by group conferences of code authorities and code committees with the Administration, and a final general conference of selected delegates of each code authority and committee with the Administrator.

Lower Wage Rate On CWA Work After March 1

Washington Correspondence.

ELIMINATION of the high PWA scale of wages on civil works has removed from the work-relief program the feature most objectionable to the construction industry. Effective not later than March 1, the wage paid will be the prevailing rate in the local community for the kind of work performed, subject to a minimum of 30c. an hour. The new minimum compares with the PWA minimum zone rates of 40c., 45c. and 50c. for common labor previously in effect.

The PWA scale was saddled on the civil works program in the first instance, because the $400,000,000 which carries it to Feb. 15 was drawn from public works funds and the PWA agreement with the building trade unions last summer stipulated that the scale should apply to all projects financed wholly or in part from the public works appropriation. As the new appropriation of $950,000,000 for civil works and direct relief was made direct to the Federal Emergency Relief Administration, the wage agreement controlling expenditure of public works funds does not apply.

CWA's quota of the new appropriation has been raised from $350,000,000 to $500,000,000. The 24-hour week in urban and 15-hour week in rural areas will remain in effect until termination of the civil works program May 1, but CWA payrolls in industrial cities will be maintained at full strength during the remainder of the winter, or until March 21 or thereabouts. Demobilization will commence immediately in rural areas according to climatic zones, with 400,000 removed from the rolls in the south this week. Approximately 150,000 also have been dropped under the McKeller amendment which prohibits employment on federal projects located on private land.

Emergency job done, says Hopkins

"Long-time planning projects will have to take the place of civil works," said Administrator Harry Hopkins, in reiterating the administration's firm intention to terminate the program by May 1. "This may include a number of devices, some of which are not now in operation. Obviously this concerns all the departments of the government. In this department we have tried to do an emergency job and it has been done. The congressional appropriations will meet the emergency needs but they do not represent a permanent policy."

Mr. Hopkins' reference to long-time planning indicates that by the time CWA folds up the administration will have outlined its new policy on public works. A feature of the remaining months of the CWA program will be the construction of consolidated rural schools.

Moffat Tunnel Commission Sued By Denver & Salt Lake R.R.

Suit for $350,000 damages on account of "the faulty design, workmanship and construction" of the Moffat tunnel was filed in the federal district court at Denver, Colo., by the Denver & Salt Lake Railroad against the Moffat Tunnel Commission. The railroad declares that "by reason of the fialure of the defendant to construct and deliver to it a tunnel as required by the contract and lease," it has been damaged and put to large expense in doing construction work that should have been done by the tunnel commission, and "will be obliged to incur heavy expense in maintaining said tunnel, due to faulty design and construction."

National Development Survey To Be Based On Water Resources

A permanent program of national development based primarily on control of water resources is the objective of a preliminary study now being conducted by a departmental committee of the national administration. The committee, which includes the secretaries of Agriculture, Commerce, Interior and War, was designated as the result of resolutions by the House and Senate asking for a correlated program for development of rivers and harbors.

The ultimate object desired, the President has announced, is a program that will provide for the maximum use of watersheds, rivers and harbor development, elimination of soil erosion, reforestation where this is desirable, land reclamation where feasible and the abandonment of agricultural lands which are found unprofitable. Into the project also enters probable decentralization of industry.

The permanent commission will study the country according to watersheds, with the country divided into three main divisions—the Atlantic area, the Gulf drainage basin and the Pacific Coast. Aside from these divisions the Mississippi Valley probably will be considered as a separate unit.

Three considerations will govern the study of each area, as follows: the topic of danger and damage to life and property, including soil erosion; the economic viewpoint, whether canals are needed or similar transportation developments; the social standpoint, whether land should be withdrawn from cultivation or whether it could support a larger population.

The commission will recommend a list of projects, based on these considerations, in the order of their importance, the list to be submitted to Congress as a guide in making appropriations, with Congress having the reserve right to change or modify the suggested projects as it may see fit.

Light-Weight Train for Union Pacific Begins Trial Runs

TRIAL runs with a new light-weight articulated train designed for high-speed passenger service on the Union Pacific system were begun on Feb. 12 following acceptance of the train by the railroad company. After a tour of eastern cities the train will be operated on special runs between the larger cities on the Union Pacific system to demonstrate its practicability for regular main-line through-passenger service, including transcontinental service. The present train has no sleeping accommodations but such accommodation will be included in a new six-car train recently ordered by the Union Pacific.

Three-car unit

The present train is a three-car unit 204 ft. long arranged as shown in the accompanying illustration. Its light weight is obtained by a radical departure from conventional car and train construction through the substitution of aluminum alloy for steel, thus attaining a total weight of only 85 tons or approximately the weight of a modern Pullman sleeping car. The entire car body forms a deep, stiff beam. It is composed of two principal structural elements, extruded aluminum alloy shapes combined with aluminum alloy plates to form the outer and inner sheathing. Between these sheaths is a 2-in. space filled with "Rokflos," a fireproof, insulating and sound deadening material. The center of gravity of the new coaches is 38 in. above the rail or 20 in. lower than that of an ordinary railroad coach.

The three units of the train are articulated with one truck under each hinge, a forward driving truck and a trailing truck under the rear car. The use of shock-absorbing or resilient wheels was considered, but was abandoned for lack of experience in the use of such wheels at the high speed expected of this train. The wheels are rolled steel equipped throughout with roller bearing journals.

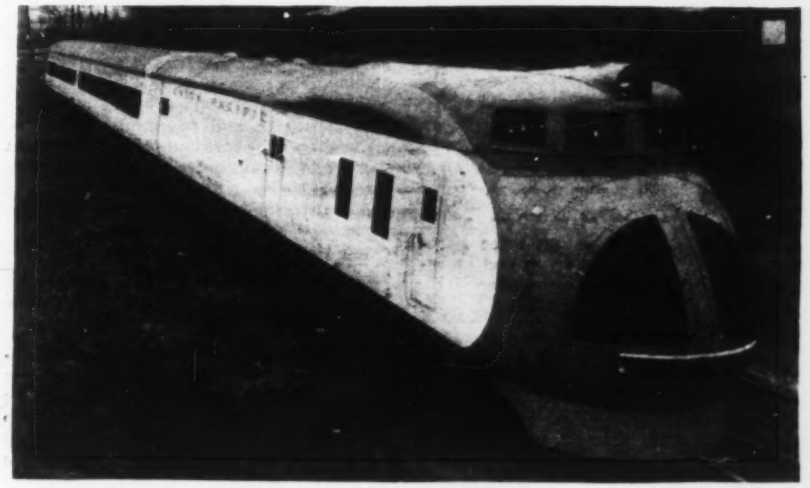
Oil-electric power plant

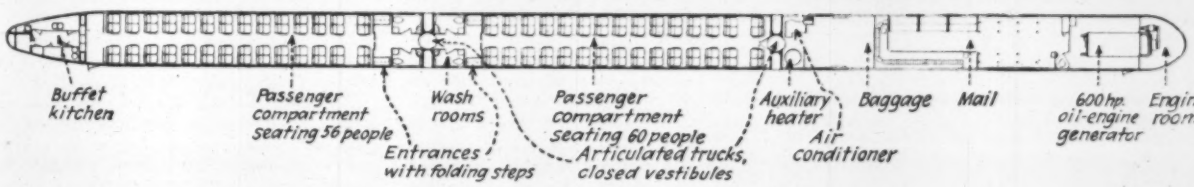
The main power plant consists of a distillate-burning internal combustion engine directly connected to a generator supplying electricity to two motors mounted on the forward truck of the first car. The engine, developed especially for this service by the Winton Engine Corp., a subsidiary of General Motors, is of the 12-cylinder V-type, rated at 600 hp. The engine frame is of welded wrought steel construction. Results obtained on test runs indicate that about 500 hp. will be required to propel the train at a speed of 90 miles an hour with a full load of passengers, baggage and mail. The generator, manufactured by Westinghouse, is rated at 425 kw., and supplies current to two General Electric traction motors, each of 300 hp., one being mounted on each axle of the front truck. The power plant includes also a small engine-driven generator for battery charging, auxiliary air compressor, air conditioning apparatus lighting and refrigeration. The fuel tanks are built into the structure under the floor of the power car. They have capacities sufficient for a 1,200-mile run.

Dual-control brake system

The air brake system is a radical departure from conventional practice; a dual system with parallel pneumatic and electric control circuits and a newly-developed appliance called a "decelerometer" to regulate the slowing down of the train. It is so arranged that the brakes cannot grab

THE NEW UNION PACIFIC TRAIN is designed for a speed of 110 m.p.h. It is built largely of aluminum alloy and weighs about as much as an ordinary sleeping car. Only 500 h.p. is required to propel it at a speed of 90 m.p.h.





THE THREE-CAR UNIT contains the oil-electric power plant, mail and baggage compartment, seats for 116 passengers and a kitchen buffet.

as do ordinary brakes or automobile brakes when too much pressure is applied.

The main operating controls are located in the elevated cab at the forward end of the train. They include a throttle which governs the speed of the engine itself, a controller by which the motorman increases or decreases the speed of the traction motor, and a brake valve to control the braking system. There is a dual set of controls for the use of a second man in the cab. The braking valve is equipped with a "deadman" control.

Two headlights are included, a powerful horizontal beam and a smaller vertical beam to supplement the audible signals warning of the approach of the train.

The side doors of the train, when closed, form a part of the smooth exterior streamlined surface. They are interlocked with the steps which fold up and down as the doors are closed or opened.

Air-conditioning

The train is fully air conditioned. A forced ventilation system heats the train in winter, cools it in summer, filters dust from the outside air and by maintaining sufficient pressure in the car prevents the entrance of dust.

Air conditioning is accomplished by distribution of filtered air through a system of ducts by means of power-driven blowers. Air outlets and corresponding exhausts are located at each seat. The lighting is entirely indirect.

Two coaches of the new train seat 116 passengers in individual, adjustable seats. A buffet kitchen is built into the rear of the last car. The dishes are of "beetleware" to save weight.

Floors are of aluminum alloy plates covered with a composition flooring surfaced with cork tile, both having heat and sound insulating qualities. All windows are of shatter-proof glass.

The actual cost of the train is not stated but the railroad company's appropriation was $200,000.

E. E. Adams, vice president, engineering, of the Union Pacific System (now vice president, Pullman, Inc.) conducted the research work under the direction of C. R. Gray, president, and W. M. Jeffers, vice president. The car was built by the Pullman Car & Manufacturing Corp., Chicago. The aluminum alloy shapes and plates were supplied by the Aluminum Company of America.

Construction of a second train of six cars has been ordered by the Union Pacific. It will consist of a 900-hp. power car, a mail and baggage car, three sleeping cars and a combined coach and observation buffet.

Paving Assessment in Oklahoma Included in Limited General Levy

The Supreme Court of the State of Oklahoma, reversing a lower court decision from Grant County, has ruled that paving tax assessments must be considered a part of the maximum 15-mill levy which the state constitution, as amended last August, permits cities, counties and school districts to make for general purposes. Grant County had attempted to levy 7.5 mills paving assessment against the Rock Island Railroad in addition to the full 15-mill assessment for general costs. The Supreme Court has upheld the protest of the railroad company against the levy.

Construction Code Authority Organized at Washington Meeting

THE Construction Code Authority was officially organized on Feb. 15 under by-laws adopted by the sponsors of the code. Nineteen out of the twenty sponsors had made their appointments of members to the code authority at the time of the meeting; eighteen out of the possible twenty-three members (the A.G.C. is entitled to four members) were present. At a previous open meeting of code committees and representatives of the sponsors, a committee on credentials had been appointed, and the proposed by-laws for the code authority had been discussed. Accordingly, the meeting proceeded to accept the report of the committee on credentials and approve the by-laws.

In the election of officers which followed, Stephen F. Voorhees, chairman of the code committee of the Construction League, was elected chairman, John P. Hogan vice-chairman, F. P. Byington treasurer, and J. W. Follin secretary. These officers will continue practically the same functions which they exercised with the Construction League code authority, which drafted the basic code for the construction industry.

Organization begun

The by-laws call for regular meetings of the construction code authority at least monthly, but an executive committee of seven members is established, comprising the chairman, vice-chairman and treasurer and four additional members to be appointed by the chairman. It will perform only such duties as are delegated by the code authority, but already has been authorized to establish and equip national headquarters in Washington, to proceed with the incorporation of the code authority, and to develop the requirements on code compliance and administration for discussion at the next meeting, to be held about March 5.

A finance committee, elected at the meeting, is to prepare a budget for code administration and to develop the procedure for registration of construction work and services by which means the statistical data will be accumulated and funds furnished for code administration through registration fees. It was indicated that this registration would probably be handled by the divisional code authorities through their regional and local administrative committees and representatives.

The construction code authority approved tentative rules and regulations for establishing the construction appeals board, which have been forwarded to the Administrator for approval and will be published after such approval is given.

Nominations to planning board

The executive committee was instructed to collect suggestions for nominations to the national construction planning and adjustment board for consideration at the next meeting. It was the prevalent opinion of many leaders attending the day's meetings, that the construction industry should nominate for appointment its outstanding thinkers and planners rather than its foremost negotiators.

Following are the members of the Construction Code Authority:

Construction League of the United States, S. F. Voorhees, Voorhees, Gmelin & Walker, Architects, New York City.

American Institute of Architects, William Stanley Parker, Sturgis Associates, Inc., Boston, Mass.

American Society of Civil Engineers, John P. Hogan, Parsons, Klapp, Brickerhoff & Douglas, New York City.

Associated General Contractors of America: building construction, A. C. Tozzer, Turner Construction Company, New York City; highway construction, Robert E. O'Connor, J. C. O'Connor & Sons, Fort Wayne, Ind.; railroad construction, N. F. Helmers, Siems-Helmers, Inc., St. Paul, Minn.; public works and other types of construction, A. E. Horst, Henry W. Horst Company, Philadelphia, Pa.

International Society of Master Painters and Decorators, Inc., Gordon P. Marshall, H. Newton Marshall Company, Boston, Mass.

Heating, Piping and Air Conditioning Contractors National Association, Robert D. Williams, Baker, Smith & Company, New York City.

Cement-Gun Contractors Association, Arthur J. White, Cement-Gun Contractors Ass'n, Pittsburgh, Pa.

National Building Granite Quarries Ass'n., J. D. Sargent, North Carolina Granite Corporation, Mt. Airy, N. C.

Contracting Plasterers International Ass'n., Oscar A. Reum, Zander-Reum Company, Chicago, Ill.

Tile and Mantel Contractors Association of America, H. R. Cole, Tile and Mantel Contractors Association of America, Washington, D. C.

National Association of Master Plumbers of the United States, Robert J. Barrett, Washington, D. C.

National Elevator Manufacturing Industry, John McArdle, Administrator, National Elevator Mfg. Industry, New York City.

Mason Contractors Association of United States and Canada, David C. Butcher, Washington, D. C.

American Road Builders Association, Louis E. Guyott, Louis E. Guyott Construction Co., New Haven, Conn.

National Association of Metal Furring and Lathing Contractors, Frank L. Adams, Williamson & Adams, Inc., New York City.

Asbestos Contractors National Association, F. P. Byington, Johns-Manville Sales Corporation, New York City.

National Association of Building Trades Employers, O. W. Rosenthal, Rosenthal, Cornell and Dwyer, Chicago, Ill.

National Association of Builders Exchanges, William P. Carroll, Cleveland, Ohio.

American Construction Council, E. M. Craig, American Construction Council, Chicago, Ill.

Roofing and Sheet Metal Industries Conference, (Not yet appointed).

PWA State Boards And Regional Advisers To Be Discontinued

TERMINATION of the services of regional advisers and all members of PWA State Advisory Boards on Feb. 28 has been announced by Public Works Administrator Ickes. At the same time there will also be terminated the services of all field personnel except such as are necessary to be retained by the State Engineers to carry on their work. The Administrator asked regional advisers and State Boards to submit final reports as near the date of Feb. 28 as possible.

Discontinuance of the services of regional advisers and State Advisory Boards marks the close of one phase of PWA activity and is in line with an order issued several days ago instructing State Engineers not to receive any more projects and to pass upon pending applications as quickly as possible and not later than the end of this month. There are now pending in the Washington offices and in State Engineers' offices non-federal applications amounting to about $3,500,000,000. This is in addition to the original $3,300,000,000 fund, virtually all of which has been allotted.

On Feb. 15 a PWA headquarters staff group, headed by Deputy Administrator H. M. Waite started a 7,000 mile trip through the country to aid local officials in speeding into construction non-federal projects which have received allotments. They will hold numerous meetings to advise with PWA field officials and local government representatives on how the construction program may be expedited.

Accompanying Deputy Administrator Waite are Edward H. Foley, Jr., Assistant General Counsel, Philip M. Benton, Director of Finance, and Michael W. Straus, Director of Public Relations.

Meetings attended by local officials were held in New York on Feb. 15, at Boston on Feb. 16 and at Detroit on Feb. 17. In addition to stops at St. Paul on Feb. 19, and Portland, Ore., Feb. 22, the schedule includes: San Francisco, Feb. 23; Los Angeles, Feb. 24; Little Rock, Feb. 26; Fort Worth, Feb. 27; and Atlanta, Feb. 28.

In Boston the party found that a proper form of bond which the state may sell to the PWA and that the government may buy has not been offered, and what approached a deadlock over the form of bond has developed, delaying a widespread building program in that state. It was arranged that a group from Massachusetts would go to Washington to finally settle on a form of approved bonds so that construction can start.

Municipal Water Project for Bath, N. Y., Disapproved

The Water Power and Control Commission of the State of New York has disapproved the proposal of the town of Bath to build a municipal water supply plant in competition with the Bath Water Works Corporation, a private company. The company's franchise expires in 1937 and the village hopes to have a municipal plant ready for service at that time. Recently the taxpayers voted $350,000 for the project.

Illinois Seeking Legislation Creating Housing Authorities

To permit cities in Illinois to take advantage of PWA housing loans and grants, or to cooperate with the P. W. Emergency Housing Corp., House bills 4 and 5, providing for housing authorities, have been introduced in the current session of the legislature, specially called by Governor Horner, Feb. 13. These public bodies would be named by the mayors or county presidents. The Illinois law is modeled after the New York law and is sponsored by Governor Horner so that early passage is anticipated. An act passed last spring authorized a state housing board in the department of public works and buildings but it provided only for private limited-dividend corporations to develop low cost housing. The housing authorities on the other hand will have power to acquire land, to construct and operate housing projects as public enterprises. To carry on these functions they will have power to borrow money on the bonds secured by mortgages on their property. The Illinois bill does not provide for tax exemption. Projects financed by federal funds will be under PWA supervision or some other federal agency and so long as this agency is operative to prevent duplication, confusion and delay the housing authorities in Illinois will not be subject to the detailed supervision of the state housing board.

Moffat Tunnel Commission Acts To Clear Title to Right-of-Way

Now that the Superior court at Wilmington, Del., dissolved the injunction issued against the Moffat Tunnel Commission, preventing it paying bond interests, the money sought for the "right-of-way" owners, the Union Exploration Company, the commission will institute suit in Gilpin county, Colorado, to quiet the title to the right-of-way.

General Manager Appointed For Federal Housing Corporation

Appointment of Horatio B. Hackett, of Chicago, as general manager of the Public Works Emergency Housing Corporation, has been announced by Administrator Ickes. The housing corporation has been allotted $100,000,000 for a construction program of low-cost housing and slum clearance.

Mr. Hackett graduated from the U. S. Military Academy in 1904. He resigned from the army in 1906 and became associated with D. H. Burnham & Co., of Chicago, Ill., as superintendent of building construction. Later he was general superintendent of the Embree Iron Company, of Embreeville, Tenn. During the war he served with the field artillery. Since 1922 he has been a partner in Holabird and Root, architects, of Chicago.

Economic Questions Predominate at Northeast Highway Association Meeting

BROAD questions of an economic and social nature such as the future of highway development in this country, development of public interest in maintenance of an adequate highway program and the financing of such a program were major subjects of discussion at the tenth annual convention of the Association of Highway Officials of the North Atlantic States held in Atlantic City, Feb. 14-16. Subjects of technical interest, nevertheless, were not lacking, there being several papers of note. Discussion of papers from the floor was more active than in the past due to the restriction placed on written discussions in order to allow time for oral discussion.

Attendance at the meeting was close to 500. Numerous manufacturers of materials used in highway work had exhibits in the hotel lobby.

Highway finance

The changing status of highway finance was emphasized at the opening session of the meeting by Arthur Foran, state highway commissioner of New Jersey, and by R. M. Reindollar, president of the association. Mr. Foran drew attention to the increased dependence on federal aid for highways and Mr. Reindollar strongly urged upon highway officials the need for checking the diversion of gas tax funds from legitimate highway use. E. C. Lawton (New York) stressed the same subject in his paper on planning a highway system to meet future requirements. There is still a strong public desire for more and better highways, he said, but the public generally is restrained from expressing this desire by the fear that continued development means increased taxes, fear roused by the railroads and those in public office who seek to maintain their appropriations at the expense of the highways.

Any study of future highway programs, said Mr. Lawton, should include all public highways and streets and should be based upon a comprehensive transportation survey. Such a survey, begun in 1922, is the basis of highway planning in New York State. Savings in operating costs in the past six-year period are about equal to the entire expenditure of the state upon its state highway system.

John A. Macdonald outlined the methods employed by the Connecticut highway department in developing and maintaining public interest in highway development. Interesting and authentic highway news is furnished to local newspapers regularly and this news is phrased in newspaper style thus insuring its easy conversion into "copy." News as to roads under construction, road conditions, etc., is sent out weekly, and in time of snow storms, records of snow fall, description of snow removal problems and information as to roads that are being kept open is given out currently.

The subject of the diversion of gasoline taxes from highway work and its effect on future programs also was the subject of an illustrated talk by Chas. M. Upham, American Roadbuilders Association, at the Thursday afternoon session and of an address by Willard T. Chevalier, publishing director, *Engineering News-Record*, at the Friday morning session.

Three papers on construction problems, chiefly as related to the current emergency

work, were presented. T. W. Allen (U. S. Bureau of Public Roads) spoke on year-round employment in highway work; A. J. Runnals (Vermont) discussed day labor work on rural roads as a relief measure, and the efficiency of the contract systems as opposed to the day labor system was the subject of a paper by Harry J. Kirk of the engineering construction division of the Associated General Contractors. A closely related paper was one by P. M. Tebbs (Pennsylvania) on the highway industry and the NRA.

Highway traffic

A plea for a better understanding of the function of traffic signals was made by Arnold H. Vey (New Jersey) who pointed out that until traffic reaches a considerable density there is no justification for signals at intersections, that where traffic is relatively light there frequently are more accidents after signals are installed than before.

Present conditions as regards total volume of traffic was the subject of a discussion by C. Hawley, Texaco National Road Reports. Mr. Hawley stated that much of the falling off in automobile mileage, with a consequent decline in gas tax returns, was due to curtailment of riding by small-income families who had abandoned automobiles or cut their travel to a minimum because of the loss of the narrow margin of their income out of which they paid for auto travel.

Technical papers

Concrete, tar and asphalt pavement design and construction were subjects of several papers at the Thursday session. Frank T. Sheets, Portland Cement Association, spoke on concrete road design, H. W. Griffin (New Jersey) on types and location of transverse joints in concrete pavements, and E. M. Fleming, Portland Cement Association, on the Elmhurst cement-bound macadam test road. Present practice in the use of tar was the subject of a paper by George E. Martin, The Barrett Company, and B. E. Gray, The Asphalt Institute, discussed recent developments in the use of asphalt.

Bonds Taken as Loan Security To Be Sold by the PWA

Following out its policy announced about ten days ago, the Public Works Administration, on Feb. 20, offered for sale the bonds of five cities that it had taken as security for loans made under the Recovery Act. Bids are to be opened on March 6; the PWA reserving the right to reject all bids.

The bonds offered for sale are:

- Bel Air, Md., $100,000, 4-per cent sewer bonds.
- Cedar Rapids, Iowa, $125,000, 4-per cent sewer bonds.
- Erie County, N. Y., $250,000, 4-per cent road and bridge bonds.
- Lynchburg, Va., $200,000, 4-per cent water-supply bonds.
- Richmond County, Ga., $162,000, 4½-per cent school bonds.

Purchasers must agree not to use the name of the United States or its agencies in the resale of these securities as indicative of any guarantee or as an inducement to buy them.

Unlicensed Surveyors Fined By Florida Court

Following pleas of guilty before the Court of Crimes, Dade County, Fla., fines of $25 each were imposed upon Fred E. Zurwelle and G. M. Whittaker for practicing land surveying without securing a proper license, thereby violating the 1931 Florida registration law.

Court Holds Surety Company Liable Beyond Terms of Bond

In an opinion delivered by Justice Cardozo on Feb. 5, the U. S. Supreme Court holds that provisions of state laws govern surety bonds even though terms of the bond specifically limit responsibility to a lesser degree than that required by statute. The opinion was rendered in an appeal from the supreme court of Mississippi decision in the case of Hartford Accident & Indemnity Co. and Aetna Casualty & Surety Co. vs. N. O. Nelson Mfg. Co. The controversy hinged upon the validity of a Mississippi statute, enacted in 1918, whereby the bond of a contractor guaranteeing to an owner the faithful performance of a contract for the construction of a building shall inure to the benefit of persons furnishing materials and labor, and this though the bond expresses an intention to exclude them. In 1926 the Natchez Investment Co. contracted with J. V. and R. T. Burks for the construction of a hotel. The Burks sublet the plumbing and heating to the Acme Engineering Co., which assigned its contract to N. O. Nelson. The general contractor defaulted with money due several, including the Nelson company. The owner relied upon the surety bond for protection, suing in the Adams County court upon the premise that Mississippi statutes required full protection to materialsmen and laborers on the part of the surety companies. Claiming liability only to the terms of the bond, which provided for recourse by the owner only, and covered only faithful performance of the contract, the surety companies appealed adverse decisions to the U. S. Supreme Court. The opinion of this court affirmed the findings of all the lower courts and held the surety companies liable to the full extent of the Mississippi statute.

Edgar Kobak Resigns; Vice President of McGraw-Hill

Edgar Kobak, vice president and general sales manager of the Mc-Graw-Hill Publishing Co. since 1926, and for eighteen years associated with the publishers of *Engineering News-Record*, has resigned. Mr. Kobak obtained his engineering training at the Georgia School of Technology and after four years with the Georgia Railway and Power Co. and a few months as a subscription salesman for the McGraw-Hill Publishing Co. became an assistant editor on *Electrical World*. Following two years of editorial work Mr. Kobak went first to Chicago and then to St. Louis as an advertising salesman for *Electrical World* and *Electrical Merchandising*. Three years later he returned to the New York office of the company to become promotion manager of *Electrical World*. Subsequently he was promoted to advertising sales manager and then to vice president and general sales manager of the company.

Engineer Board Starts Study Of Chicago Sewage Plans

A study of the construction plans of the Sanitary District of Chicago has been begun by an engineering board of review in accordance with the stipulation of the Public Works Administration when it made its allocation to the District for sewage plant construction.

Members of the commission are D. W. Mead, professor of hydraulic and sanitary engineering, University of Wisconsin; Charles W. Kutz, consulting engineer, Washington, D. C.; W. B. Storey, former president of the Atchison, Topeka & Santa Fe Railroad; and Joshua D'Esposito, ex officio, Illinois PWA engineer.

Silicosis Hazard Discussed at New York Meeting

Two entire sessions of the 143rd meeting of the American Institute of Mining and Metallurgical Engineers in New York, Feb. 19-22, were devoted to the subject of mineral dust hazards with particular emphasis on silicosis. Facts concerning the cost of this disease to industry, chemical and X-ray methods of diagnosing it and the best preventative measures available were presented. Exhibits of types of dust-collecting apparatus were also shown, as were sections of lungs indicating the irreparable damage that silica dust causes. The program included the following papers: What May the Hazards from Mineral Dusts Cost Industry, by Benjamin F. Tillson; Pathological Researches with Mineral Dusts, by Dr. Leroy U. Gardner; Comparison of Methods of Dust Sampling and Counting, by Dr. Leonard Greenburg; and Meeting the Dust Problem when Drilling Rock, by R. A. Brackett. Chemical and X-ray demonstrations on silicotic persons were conducted by Dr. Adelaide Ross Smith and a discussion of the pneumonoconiosis research sponsored by Columbia University completed the program.

SOCIETY CALENDAR

AMERICAN RAILWAY ENGINEERING ASSOCIATION, Chicago, Ill., March 13-14, 1934.

AMERICAN SOCIETY FOR TESTING MATERIALS, Atlantic City, N. J., June 25-29, 1934.

AMERICAN WATER WORKS ASSOCIATION, annual convention, New York, June 4-8, 1934.

SMOKE PREVENTION ASSOCIATION, annual convention, June 19-22, Buffalo, N. Y.

MARYLAND ASSOCIATION OF ENGINEERS at its fifth annual meeting in Baltimore on Feb. 9 elected S. S. Steinberg, professor of civil engineering at the University of Maryland, president.

OHIO ENGINEERING SOCIETY, at its fifty-fifth annual meeting in Columbus, elected president, T. S. Brindle; of Ashland, state director of public works.

FIFTH ANNUAL GREATER NEW YORK SAFETY CONFERENCE will be held in New York City on March 6 and 7. The meeting will be divided into fifteen sections, each section devoted to some specific phase of accident prevention work.

KENTUCKY ASSOCIATION OF HIGHWAY CONTRACTORS, at its annual meeting on February 3, in Louisville, elected J. C. Codell, of Winchester, Ky., president. A resolution was passed at the session, directing the secretary to prepare and submit a bill to the legislature providing for the prequalification of highway contractors.

NEW JERSEY SEWAGE WORKS ASSOCIATION will hold its nineteenth annual meeting at Trenton on March 22 and 23.

Personals

SAMUEL H. LEA has been appointed engineer examiner with the Public Works Administration at Washington, D. C.

JULIUS W. BUGBEE, superintendent of the Providence, R. I., sewage treatment plant, has been appointed vice-chairman of the Federation of Sewage Works Associations.

HAROLD E. WESSMAN has accepted an appointment as associate professor of mechanics and structural engineering at the State University of Iowa, and has resigned as superintendent of the water department of the city of Rockford, Ill.

ROBERT KINGERY, acting director of the Illinois State Department of Public Works and Buildings, has been appointed to the directorship by Governor Horner and his appointment has been confirmed by the State Senate. He has been acting director for several months.

CHARLES C. BRUSH, Philadelphia, Pa., formerly assistant engineer in the marine engineering division of the Lighthouse Service in Washington, D. C., has been appointed superintendent of the first Lighthouse District which embraces the waters of Maine and New Hampshire. His new office will be located at Portland, Maine.

JOHN F. MCDONALD has been appointed a member of the Boston Transit Commission, succeeding Nathan Heller, recently resigned. Mr. McDonald has been prominent in Boston legal circles for many years. The commissioners of the Transit board have general jurisdiction over tunnel and subway construction in Boston.

Obituary

WILLIAM C. HARTIGAN, contractor of Geneva, N. Y., died at his home in that city on Feb. 8. Mr. Hartigan constructed many of the churches and business buildings in the Geneva district.

JAMES MORLAND JOHNSON, consulting engineer of Louisville, Ky., died on Feb. 13 at the age of 76. A week earlier Mr. Johnson had been appointed city building inspector. He was born in Owensboro, Ky., and graduated from the Rensselaer Polytechnic Institute. He was for 30 years president and chief engineer of the Louisville Bridge & Iron Co., leaving that connection in 1913 to enter private practice.

GEORGE N. RIKER, chief engineer of James Stewart & Co., Inc., contractors, New York, N. Y., died suddenly on Feb. 12 at his home in East Orange, N. J. Mr. Riker was a graduate of Rensselaer Polytechnic Institute and joined the Stewart organization in 1910, having previously been associated with Westinghouse Church Kerr Co. Starting as a draftsman, Mr. Riker became designing engineer and for several years before becoming chief engineer in 1923, was in charge both in the office and in the field of numerous large industrial and hydraulic projects. He had charge of the widening of the roadway on Park Ave. in New York City over the New York Central right-of-way and the changes in the substructure of the Grand Central Terminal necessitated by the construction of the New York Central Building. The most recent works in his charge were the construction of several sections of the West Side Elevated Highway, the new West Side viaduct for the New York Central Railroad, and the St. Johns Park freight terminal.

CONSTRUCTION STATISTICS OF THE WEEK

TWO short weeks in succession, due to the Lincoln and Washington birthday holidays, hold the engineering construction awards for this week at $17,433,000 compared with $21,236,000 last week, a previous four weeks average of $21,117,000, and last year's February average of $15,128,000 per week. This week's total represents a large number of smaller projects rather than a few large contracts. Private work is higher, $4,362,000 compared with $3,812,000 last week, and public work is down, $13,071,000 compared with $17,424,000 last week.

Highway awards climbed to $6.9 millions, public buildings dropped to the low for the year, $1.4 millions, bridges dropped to $0.7 million the low for the year. Commercial buildings registered the year's high, $3.7 millions. Both federal and state and municipal awards were below the year's average to date.

Large lettings include the San Francisco Roosevelt Terrace Housing Development, eleven 2-, 3- and 6-story apartment houses, a PWA limited dividend housing project, $3,230,000; highways: $567,000 by Georgia, $1,302,000 by New York, and $739,000 by Ohio; dredging, $751,000 by the Corps of Engineers in Michigan, and Sewer Contract 6 for West Side Intercepting Sewer in Chicago, $1,124,000.

New capital is only slightly higher than last week. $7,968,000 compared with $7,714,000. This total includes $4,236,000 in PWA loans to corporations and $200,000 in a loan and grant to a municipality. Municipal bond sales for construction purposes total $3,532,000 compared with $6,378,000 last week. Last week's total, however, included one $5,000,000 issue, while this week's total includes a larger number of small issues. The technical position of the municipal bond market continues good. Prices are reported highest on record. Sales of refunding, poor relief and welfare bonds are not included in "new capital" statistics.

CONTRACTS

(Thousands of Dollars)

	Weekly Feb. 1933	Average Prev. 4 Weeks	Week Feb. 12 1934
Federal Government	$3,737	$5,068	$2,956
State and municipal	5,873	12,474	10,115
Total public	$9,611	$17,542	$13,071
Total private	5,517	3,575	4,362
Week's total	$15,128	$21,117	$17,433

Cumulative to date:
1933.....$155,905 1934.....$180,842

NEW PRODUCTIVE CAPITAL

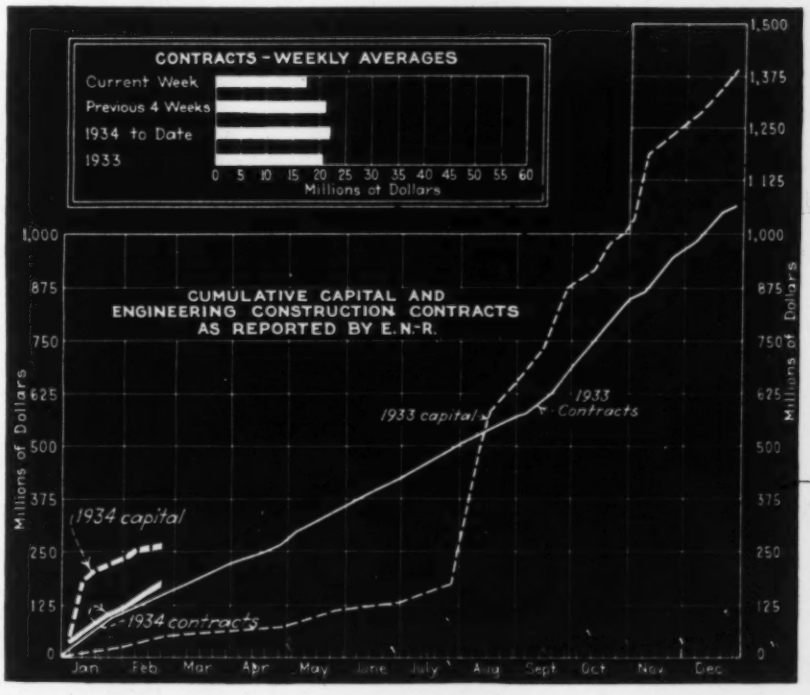
(Thousands of Dollars)

1934	Week Feb. 22	Cumulative
State and municipal	$3,532	$38,943
PWA allotments, S&M	200	176,161
Corporate issues	....	10,418
PWA allotments, private	4,236	40,788
Total, Non-Federal	$7,968	$266,310
PWA allotments Federal Constr.	55	45,789
Total new capital	$8,023	$312,099

Cumulative to date:
1933.....$54,600 1934.....$266,310
Rescinded or reduced allotments (from 1933 PWA totals)..... $34,399

INDEX NUMBER

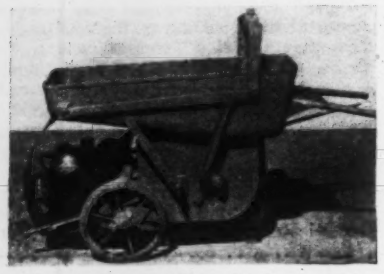
E.N.-R.-Cost		E.N.-R.-Volume	
February, 1934	**194.04**	**January, 1934**	**113**
January, 1934	191.26	December, 1933	116
January, 1933	159.30	January, 1933	129
1933 (Average)	170.28	1933 (Average)	102
1932 (Average)	156.97	1932 (Average)	127
1931 (Average)	181.35	1931 (Average)	226
1913 (Average)	100		



Construction Equipment and Materials

Mud Jack Raises Concrete Slab

National Equipment Corp., Milwaukee, Wis., has developed a mud jack for saving curb and gutter, sidewalk and street slabs, to eliminate the necessity of reconstruction. The new model, designated No. 10—N.E.C., is a small unit weighing less than 400 lb.



New model mud jack

The pressure at the 2½-in. nozzle directly below the pump is about 100 lb. per sq.in. The machine is equipped with a 1¼-hp. air-cooled engine, and has a normal capacity of about 1¼ cu.yd. per hour.

New Limitorque Valve Operator

The Philadelphia Gear Works has completely redesigned the Limitorque electric valve-operating mechanism. The control consists of a self-contained reducing-gear unit with mechanical and electrical limit built into it. The valve-operating nut is incorporated in the casing and is supported by heavy-duty Timken roller bearings.

The motor operates at 1,800 r.p.m., with speed reduction by helical gear and steel bronze worm. The whole mechanism is immersed in oil, and is completely inclosed. It comes in 3 sizes, which, with two motors per frame, allows six combinations.

Valves of 3-in. to 72-in. diameter can be operated. The machine is adaptable to gate and globe valves, sluice gates, dampers, and for any mechanism having a definite movement that must be stopped or reversed at the end of travel. It can also be adapted to existing hand-operated valves. Headquarters for the sale of this device are at 330 West 42nd St., New York City.

Newly designed Limitorque electric valve-operating device

New Equipment in Brief

Concrete Mixer. Koehring Co., Milwaukee, Wis., announces the new 10-S Dandie two-bag mixer. It is equipped with anti-friction bearings, the frame is mounted on the axle by means of two springs at the rear and one at the front, and the entire machine weighs only 3,800 lb.

Dragline Bucket. The Northwest Engineering Co., Chicago, Ill., has recently announced a new wide-mouth light-weight dragline bucket. It is built in three sizes, 54, 67½ and 81 cu.ft. capacities, struck measure. The lip is of rolled alloy steel, and both arch and lip are toughened by heat treating.

Air-Cooled Engine. The Wisconsin Motor Corp., Milwaukee, Wis., has brought out a heavy-duty four-cylinder air-cooled engine of 6 to 16 hp. capacity. This engine is called Model AC4 and develops 10 hp. at 1350 r.p.m., 12 hp. at 1,600 r.p.m. and 16 hp. at 2,600 r.p.m. The engine is characterized by light weight.

Tractor. Caterpillar Tractor Co., Peoria, Ill., has announced the 28 tractor to succeed the model 25. According to the manufacturer, the engine of the new tractor develops a maximum of 30.5 hp. at the drawbar and 37.5 hp. at the belt. Ground contact, with standard tracks, is 1,251 sq.in. and shipping weight is 7,870 lb.

Diesel Engines. Fairbanks, Morse & Co., Chicago, Ill., has developed and placed on the market a light-weight four-cycle diesel engine available in sizes of 1, 2, 3, 4 and 6 cylinders with capacities of 10, 20, 30, 40 and 60 brake horsepower. The cylinder size is 4½x6 in. and the normal operating speed is 1200 r.p.m.

Vertical compressor. Gardner-Denver Co., Quincy, Ill., has announced a new line of vertical compressors, designed to achieve greater savings in air compressor costs. Inlet and discharge valves are cushioned, and are silent and durable. Extra large water jackets completely surround the cylinders and valves. A water-cooled intercooler saves power and increases volumetric efficiency by cooling air between stages.

Paver. An improved black-top paver has been announced by the Adnun Engineering & Mfg. Co., Nunda, N. Y. The paver is self-propelled and rolls on the subgrade and finished course. It consists of a hopper mounted on a frame carrying an operating platform and engine. The front end is supported by two wheels that are engine-driven and steered from the platform. The rear end is mounted on four rollers also powered and controlled for steering. An agitator bar at the bottom of a hopper draws the paving material down to the grade where it is cut off by a moving cutter bar similar to that of a mower.

Business Notes

JEFFREY MFG. CO., Columbus, Ohio, has opened offices in the Carew Tower Building, Cincinnati, and in the Rockefeller Building, Cleveland, Ohio.

JOSEPH T. RYERSON & SON, INC., Chicago, Ill., announces that it has purchased the stock and good will of Bacon & Co., an iron and steel firm of Boston, Mass.

WORTHINGTON PUMP & MACHINERY CORP., Harrison, N. J., announces the election of A. G. Pratt, president of the Babcock & Wilcox Co., to the Board of Directors.

J. D. CHRISTIAN-ENGINEERS, San Francisco, Calif., has been licensed by the Falk Corp., Milwaukee, Wis., for the manufacture of Rite-lo speed motors under the original Christian design. The Falk Corp. is the new owner of the patent issued to J. D. Christian.

AMBLER ASBESTOS SHINGLE & SHEATHING Co. and the Keasbey & Mattison Co., both of Ambler, Pa., have merged and the controlling interest in the company has been acquired by Turner & Newall, Ltd., of Great Britain. The enlarged business will retain the name of Keasbey & Mattison Co. and will remain under American management.

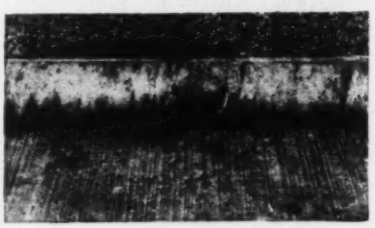
LINK-BELT CO., Chicago and Philadelphia, has been granted a license to manufacture and lease the small tunnel shield developed by the Tunnel & Mine Machinery Co., Otis Bldg., Philadelphia. The shield will drive soft-ground tunnels from 4 to 8 ft. internal diameter for sewer and conduit construction. A precast concrete block lining is erected within the shield as tunneling progresses.

Improved Centrifugal Process for Casting Iron Pipe

An improvement in the method of manufacturing cast-iron pipe by the de Lavaud or centrifugal process has been announced by the United States Pipe & Foundry Co., Burlington, N. J. The improvement consists of reducing the rate of cooling of the molten metal after it is deposited in the revolving mold, and results in a more resilient metal. Pipe manufactured by the improved process is called Super de Lavaud.

An insulating material is used between the molten metal and the mold. This insulation is a refractory material in a powdered form, and is applied by the aid of a jet of compressed air directly against the inside face of the revolving mold immediately ahead of the iron.

Retarding the rate of cooling by this means produces a cast iron quite different from that obtained by the ordinary de Lavaud process. The iron is much more resilient and the new pipes are capable of withstanding far more impact.

The manufacturer claims that the new pipe is much more resistant to the shock stresses that come from handling and transporting. Breakage is materially cut down. Tensile strength of the metal in the new pipe is about the same as that in the old.

Super de Lavaud pipe, 6-in. diameter, tested to failure by 250-lb. hammer on 7-ft. span.